REPORT OF THE

NATIONAL COMMISSION ON AGRICULTURE

1976

PART VIII

FISHERIES

GOVERNMENT OF INDIA
MINISTRY OF AGRICULTURE AND IRRIGATION
NEW DELHI

PRINTED BY THE MANAGER GOVERNMENT OF INDIA PRESS NASIK-422006 AND
PUBLISHED BY THE CONTROLLER OF PUBLICATIONS DELHI-110006, 1976

PREFACE

The Report of the National Commission on Agriculture comprises 69 chapters in 15 parts. A complete list of chapters and parts is given in pages (iii) and (iv). The Terms of Reference of the Commission and its composition are given in Part I—Chapter I—Introduction.

This volume, entitled 'Fisheries' is Part VIII of the report and is divided into the following four chapters:

37. Inland Fisheries and Aquaculture
38. Marine Fisheries
39. Crustacean Fisheries and their Utilisation
40. Marketing of Fish and Fishery Products

Fisheries education forms a separate section in Chapter 53 on Education and fisheries research has been discussed in Chapter 52 on Research in Part XI. Improvement of fisheries statistics has been dealt with in Chapter 61 on Statistics in Part XIV. Certain other aspects of fisheries find mention in relevant portions of different chapters.

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INLAND FISHERIES AND AQUACULTURE

I INTRODUCTION

37.1.1 Fish production from inland waters is of great significance to India, because it is based on water resources spread throughout the country and is capable of making a substantial contribution to the requirements of animal protein for the people. In the non-maritime States, freshwaters alone contribute to fish production, whereas the maritime States have inland resources comprising both fresh and brackish waters, besides the marine resources. The inland fisheries have one great advantage in that the source of production is close to the consuming centres. This reduces the problems of preservation and transportation and, consequently, the cost of distribution. The entire catch of inland fish is directly utilised as human food and hardly any quantity is processed for meal, manure or oil. Lastly, the inland fishes have a high market value in the hinterland of the country, particularly in the regions having a preferential demand for these fishes, as in the eastern States of India.

Production Trends

37.1.2 The collection of inland fishery statistics, as is being done in the field of marine fisheries by adopting a suitable methodology and mechanism, has not made much progress in many areas of the world, including India. The estimates of inland fish production are, therefore, not as reliable as those of the marine catch. In India, the inland fish production, for the period 1951 to 1961 has been estimated as 40 per cent of the marine fish production, computed from the proportion in the market arrivals of the marine fish and inland fish. These estimates have been based on a survey undertaken in 1951 by the Directorate of Marketing and Inspection. From 1961 onwards these estimates for the country and for each State separately, have been based on the information furnished by the States to the Ministry of Agriculture & Irrigation. It has been reported that the States have been estimating their respective production on the basis of market arrivals of inland fish, water area leased out, value of lease amounts etc. Even this method was not considered satisfactory. Improved methods of collecting inland fishery statistics have been discussed in Chapter 61 on Statistics.

37.1.3 The world production from inland water resources which contributes about 14 per cent of the total fish production increased from 6.93 million tonnes in 1964 to 9.53 million tonnes in 1971. Of this, as much as 45 per cent was the contribution made by China alone, whereas India occupied the third place next to the USSR. The inland fish production in India increased from 218,000 tonnes in 1951 to 277,000 and 690,000 tonnes in 1961 and 1971 respectively, with corresponding annual growth rate of 2.72 and 14.88 per cent. The annual growth rate was significant during the period 1961-71, but production remained almost static during 1969-72 as can be seen from the following figures:

Year	Production (thousand tonnes)
1969	693.2
1970	670.5
1971	690.5
1972	665.8

37.1.4 Appendix 37.1 gives the Statewise annual average production of inland fish during the triennia 1961-63, 1964-66, 1967-69 and 1970-72 as also the maximum annual production attained during the period, namely, 1961-1972. It would be seen that at the all-India level production increased as follows:—

Triennium	Production (thousand tonnes)	Percent increase over previous triennuim
1961-63 (base level)	332	..
1964-66	483	45
1967-69	617	41
1970-72	674	17

The percentage contribution of each State to the all-India production is given in column 6 of the Appendix. It would be seen that the States of West Bengal, Tamil Nadu, Andhra Pradesh, Bihar and Karnataka together contributed as much as 80 per cent of the total annual fish production in the country. Their individual contribution was 34 per cent in the case of West Bengal, 16 per cent in the case of Tamil Nadu, 13 per cent in the case of Andhra Pradesh with Bihar and Karnataka accounting for 9 per cent and 8 per cent respectively. The contribution of each of the States of Assam, Uttar Pradesh, Orissa, Kerala, Gujarat and Maharashtra varied from 2—4 per cent of the all India production with the rest of the States together contributing the balance 4 per cent. The Production of inland fish went up by 5.6 times in the case of West Bengal during this period (1961-1972) whereas in the remaining States, except Kerala and Gujarat, the increase did not exceed 2.5 times. The production in the State of Kerala increased 14 times, i.e. from 1,090 tonnes to 14,190 tonnes and in Gujarat 230 times, i.e. from 60 tonnes to 13,820 tonnes. These phenomenal increases, however, did not have a significant impact on the average production level of the country as their contribution to all-India production amounted to only 4 per cent. It may also be added that the year of peak production during the period 1961-72 in the major fish producing States of West Bengal, Tamil Nadu and Andhra Pradesh was 1969 which incidentally happened to be a year of maximum inland fisheries production in the country.

37.1.5 Inland fish production takes place in freshwater and brakishwater resources, each type having capture and culture fisheries. Fishing from natural stocks in the same manner as hunting is known as capture fisheries. The impoundments of waters which are comparatively smaller in extent such as ponds and tanks and which require stocking of seedfish followed by periodical harvesting, constitute culture fisheries. The impoundments of extensive water spreads such as reservoirs are progressively increasing in number. They constitute culture fisheries so long as stocking of seedfish is necessary and turn into capture fisheries when fish start breeding in these resources and stocking is no longer necessary. The freshwater resources comprise riverine systems, reservoirs, ponds and tanks, ex-bow lakes etc., whereas brackishwater resources comprise capture fisheries in estuaries and lakes and culture fisheries in ponds. The main emphasis in inland fisheries development during the five year plans has been on the culture fisheries. In each plan a progressively increasing area of freshwater such as ponds, tanks and reservoirs, is brought within the programme of stocking with the seedfish of Indian major carps, *catla-Catla catla* (Ham.), *rohu-Lobeo rohita* (Ham.) and *mrigal-Cirrhinus mrigala* (Ham.). It can, therefore, be stated that the culture fisheries has conributed the major share towards increase of fish production. The capture fishery resources are affected by ecological changes brought about by floods and drought, construction of dams and barrages, and by water pollution.

37.1.6 India has vast inland water resources spread throughout the country. Inland fish is comparatively reasonably priced and is in great demand. Augmenting its production, particularly from culturable resources with the application of latest aquaculture technology, therefore, acquires considerable importance.

2 RIVERINE FISHERIES

37.2.1 The rivers of India are broadly classified into the Himalayan and the peninsular rivers. The former comprise the Indus, the Ganga and the Brahamaputra systems. The peninsular rivers are further divisible into coastal streams (as many as 600[1] on the west coast and a few on the east coast) and the inland rivers which comprise the Narbada and the Tapti flowing westwards and the Mahanadi, the Godavari, the Krishna and the Cauvery flowing eastwards. The total length of the main rivers and their tributaries, as computed by the Central Inland Fisheries Research Institute, Barrackpore (near Calcutta) (CIFRI), is about 29,000 km.

37.2.2 The three Himalayan rivers together with their tributaries have their origin in the glaciers of the Himalayas and are perennial since they are fed by the melting of the snow in spring and summer months and are rainfed during monsoon. The peninsular rivers, on the other hand, are only rainfed, and since the monsoon is limited to about four months, these rivers are in very low flow during the premonsoon months; they even tend to dry up during this period, particularly in the upper and middle reaches. It would be natural to expect more flourishing fisheries in rivers having a perennial flow pattern. The riverine systems in the plains are characterised by the occurrence of warm water fisheries and those in the high altitude by cold water fisheries.

Warm Water Fisheries

37.2.3. The bulk of the riverine fish production comes from the warm water fisheries. The catch mainly comprise carps, catfishes, feather-backs, murrels and Hilsa or Indian-shad, *Hilsa ilisha* (Ham.). The Indian major carps viz., *catla, rohu* and *mrigal* are considered to be the most favoured freshwater fishes and have, therefore, special importance in the production aspect from all types of freshwater resources, whether capture or culture. There is a significant difference between the warm water fisheries of the Himalayan and the peninsular rivers. There is great abundance of major carps in the former, whereas the major carp fishery in the latter is either poor or absent. This difference is clearly reflected in the catch composition and production in the two types of rivers.

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[1] 1972 Report of the Irrigation Commission 1:21. New Delhi Ministry of Irrigation and Power, Government of India

37.2.4 The fishing intensity along the course of a river varies from stretch to stretch, depending upon the current velocity, terrain of the river bed, approachability, general productivity of the waters etc. It is on this account that riverine fishing has assumed importance only in some stretches of the rivers. But taking the riverine resources as a whole, it may be stated that fishing in them is of a very diffused nature. Consequently, it has not been possible to collect all-India information with regard to the riverine fish production, total number of fishermen engaged in riverine fishing, number of craft and gear employed etc. In the absence of this information the statistics collected by CIFRI for certain important stretches of the Ganga, the Yamuna, the Narbada and the Godavari, give useful indication of the utilisation of the riverine resource. The average annual catch per km length of the rivers passing through the various specified zones is given below:

River	Zone	Average annual catch (1958-59 to 1968-69) tonnes/km
Yamuna	Agra	0.643
Ganga	Allahabad	0.892
Ganga	Kanpur	1.332
Ganga	Varanasi	1.387
Ganga	Buxar	1.463
Ganga	Ballia	0.873
Ganga	Patna	1.608
Ganga	Bhagalpur	0.700
Narbada	Hoshangabad	0.364
Godavari	Dowleishwaram to Dummagudem	1.125

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It is seen that the catch per km lies in the range of 0.643 and 1.608 tonnes averaging about 1.0 tonne per km. It would not, however, be correct to compute the production from the riverine resource on this average because in other stretches of the aforementioned rivers and in other rivers the catch would not be comparable. It could, however, be reasonably assumed that riverine fish would not exceed 25,000 tonnes from 29,000 km of rivers. The CIFRI has also made an inventory of the number of fishermen per km in certain stretches of the rivers as specified below :

Name of the river	Stretch	Length (km)	No. of villages	No. of active fishermen	No. of fiishermen per km
Ganga . . .	Bulandshahr to Murshidabad	3,120	1,577	24,608	7.8
Yamuna . .	Agra to Allahabad	730	537	3,164	4.3
Narbada . .	Mandla to Blaroch	945	712	3,082	3.2
Tapti . . .	Deodongri to Nagdala	728	575	5,242	7.2
Godavari . .	Trimbakeshwar to Dowleisnwaram	1,412	..	7,391	5.2

The average number of fishermen per km comes to be 6.5. Considering that the average annual catch comes to nearly one tonne per km and the number of fishermen engaged would be about 6.5, the average catch per fishermen comes to about 150 kg, which indicates very low per capita productivity. There is thus need for improving per capita productivity of fishermen dependent on riverine fisheries. The Commission recommends, therefore, that the ICAR may take steps towards improvement of fishing gear and their adoption keeping in view the conservation of riverine fish stocks.

37.2.5 Fishing is undertaken by operating different types of gears viz., shore-seines, boat-seines, gill-nets, hook and line fishing, and various types of traps. Synthetic materials have been progressively used in fabricating fishing nets. While investigating the declining trends in fishery production in the lower reaches of the river Godavari, the CIFRI noticed that the usual practice of the fishermen was to resort to nets having smaller meshes. This is done to catch even smaller sizes so as to keep up the total catch and heir earnings, irrespective of the long range adverse effects such practices may have on the fish stocks. There is, therefore, a need for controlling such practices by registering the crafts and gears with a view to conserving the fish stocks in the riverine resources where fishing is undertaken without any licensing or permit system.

37.2.6 The transplantation of major carps in the peninsular rivers, which were devoid of these fishes, has been under consideration for the development of riverine fisheries to increase production. The establishment of major carp fisheries in the Godavari and the Cauvery are steps in this direction. The occurrence of major carps in the Narbada and the Tapti has been reported as an example of accidental transplantation or what may be termed as the natural process of transplantation. The occurrence of major carps has now been recorded in almost all the major peninsular rivers which were once considered to be devoid of these fishes. Besides, the stocking of major carps and establishment of this fishery in the reservoirs would further increase the chances of natural transplantation occurring in the rivers both upstream and downstream. An important consideration in this context would be the raising of adequate quantities of seedfish for stocking rivers in circumstances of acute shortage even for fish culture in ponds and tanks. It would, however, take a long time to spare adequate stocking material for transplantation to the rivers. Considering these aspects, it would be desirable to pay attention to the commercially important indigenous fishes of different rivers e.g. local species like fringe-lipped carp, *Labeo fimbriatus* (Bl.) and catfishes for increasing production.

37.2.7 The construction of dams and weirs is known to affect riverine fishery because of reduction in the flow of water in the downstream of rivers. The effect of river valley projects on riverine fishery has not been studied in detail. This indicates the need for the pre- and post-impoundment studies. Such studies would give an idea of the loss in the riverine fishery as against the possible gains in the reservoir fishery, and may pinpoint steps to minimise adverse effects in the downstream fishery. There are examples in other countries where the preservation and improvement of the original riverine fishery in the downstream have been effected by allowing regulated discharges from reservoirs as originally provided for in the river valley projects. The need for such a provision should also be considered in our country. It is, therefore, suggested that the State Fisheries Departments should undertake pre-impoundment studies on riverine fisheries in the planning stages of the river valley projects with a view to examining and suggesting the necessity of making provisions for regulated discharges for minimising the losses in the downstream fishery of the rivers.

37.2.8 The rivers constitute an important means for the migratory run of the anadromous fish, *Hilsa,* which ascends the rivers from the sea. There are some indications of two annual runs, one during the south-west monsoon and the other during winter. Being one of the most popular and esteemed food fishes, the migratory run of *Hilsa* is exploited as an important fishery in almost all the river systems and estuaries including Chilka lake, yielding about 4,000 tonnes per annum in the country. The studies have indicated that each major river system and the Chilka lake have their own stocks of *Hilsa.* In the case of the river Ganga, two stocks are known—one freshwater in the middle reaches and the other in the lower reaches coming from the sea. The construction of dams, barrages or anicuts in the migratory course of *Hilsa* would inevitably cause deleterious effects on its fishery, particularly by way of reducing its spawning stretches. This is illustrated in the case of the river Roopnarain by the construction of the dam by the DVC, in the Godavari by the anicut at Dowleishwaram, in river Krishna by the Vijayawada anicut and in the river Cauvery by the lower Coleroon anicut. There are several instances in other countries, where in similar situations, the adverse effects have been minimised or even overcome by providing appropriate fish passes or fish guiding devices. The success of such devices would depend on elaborate studies, both in the field and in the laboratory. It is, therefore, suggested that the authorities concerned should appreciate the desirability of providing suitable arrangements so as to minimise losses in *Hilsa* fishery resulting from construction of barriers in the course of its migratory run. The concerned State Fisheries Departments should undertake investigation on *Hilsa* fishery from this aspect, in consultation, and in collaboration, with ICAR, with a view to suggesting necessary steps.

37.2.9 Studies on *Hilsa* fishery conducted by CIFRI, have also revealed that the operation of nets which catch considerable quantities of juveniles affects the fishery. In the interest of conservation of this important fishery, the concerned States should undertake necessary measures to enforce restrictions on the operation of such gears as would adversely affect juveniles.

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Cold-water Fisheries

37.2.10 Fisheries in streams and lakes, situated in high altitude regions of the country, comprise indigenous fishes chiefly the mahseer, the snow-trout, and the exotic species mainly of the trout. Until recently, the developmental work in cold water fisheries was directed towards establishing trout fishery which is the most popular sport fish in the world. There has, however, been growing realisation for developing indigenous cold water fisheries. The production from cold water fisheries is, however, not of much significance in the total inland fish production of the country.

37.2.11 Trout fishery: Several attempts were made to introduce trout by importing eyed ova. Beginning was made in 1863 with the streams in the Nilgiri Hills in the south and in 1895 in the streams in Kashmir in the north. Success in establishing trout in the country, in both in the north and the south, was achieved around 1905. In the snowfed north Indian trout streams, comprising about 1,020 km in Jammu & Kashmir, and 250 km in Himachal Pradesh, it is mainly the brown trout (*Salmo trutta fario*) which provides the sport. In the spring-fed south Indian trout streams of about 34 km in the munnar High Range in Kerala, 70 km in Kodai Hills and 8 km in the Nilgiris in Tamil Nadu, it is mainly the rainbow trout, (*Salmo gairdneri*) both 'shasta' and 'irrideus' strains, which provides sport.

37.2.12 There is very low intensity of natural recruitment in trout because of low fecundity of females, specific requirements of a substratum for digging the nests or 'redds' limiting the spawning locations, long incubation periods etc. They have to be extensively propagated all over the world, by artificial fertilisation and rearing the fertilised eggs to fry stage in hatcheries and then releasing the young ones in the streams.

37.2.13 In recent years, there have been improvements in other countries in hatchery operations. These involve incubator devices having the advantage of using small volume of water at controlled temperature for either accelerating or retarding the rate of development of eggs as desired, and supplying balanced dry feed for getting the maximum survival of fry. As against these developments in other countries, the hatcheries located at different trout farms in India, established since the time of introduction of trout, continue to operate without any device for controlling the temperature of water. This has resulted in exposing the fertilised eggs to unusually longer periods of incubation, thereby increasing the exposure of developing stages to various diseases, resulting in considerable mortality. Added to this is the continuation of the old practice of giving an unbalanced as well as expensive diet, comprising egg-yolk, liver and silkworm pupae to the fry and fingerlings, which results in a very low rate of survival of the young ones. This very much reduces the stocking necessary to maintain the trout population in the existing trout streams. Assessing the trout population in the Sind and Lidder streams in Kashmir during 1969 and 1970 by creel census, the CIFRI has indicated the possible decline in the average catch per rod. It is, therefore, suggested that the concerned States, in consultation with ICAR, should examine the possibilities of introducing innovations in hatchery practices and of developing artificial feeds which would assure higher survival rate of the young trout. This would provide for increased rate of artificial propagation in the existing streams and for transplantation in the new streams.

37.2.14 Mahseer fishery: This fishery consists of several species, of which the principal ones are *Barbus* (*Tor*) *putitora*, (*Ham.*), *B* (*Tor*) *tor* (Ham), *B*. (*Tor*) *mosal* (Ham), *B*. (*Tor*) *Khudree* (Sykes), and *B*. (*Tor*) *mussallah* (Sykes). These have their own ranges of distribution, including the river systems of lower altitudes. The *Putitor* mahseer, which grows to the maximum size of about 275 cm occurs all along the Himalayas from Kashmir to the Darjeeling Hills; in Himachal Pradesh and the Punjab, it forms an important fishery of the Beas and Sutlej rivers and their tributaries. The *Tor* mahseer, which attains the maximum size of about 150 cm is widely distributed along the foothills of the Himalayas and in the Narbada river. In the latter, it constitutes an important commercial fishery accounting for nearly 28 per cent of the catches near Hoshangabad in Madhya Pradesh. The *Mosal* mahseer which also attains a length of about 150 cm appears to be more common in Burma than in the Himalayan streams; the Mahanadi variety of this mahseer is known to occur in the Mahanadi. The *Khurdree* mahseer which attains a length of about 145 cm occurs in the Uttar Pradesh, Orissa and peninsular India. The *Mussallah* mahseer which attains a length of about 120 cm also occurs in the freshwaters of peninsular India. The fishery of mahseers is important both for commercial and sport fishing.

37.2.15 The mahseer are known to undertake generally long range upstream migration in pre-monsoon and monsoon months in search of suitable grounds for breeding. In Himachal Pradesh and Kashmir the commercial catch of the *Putitora* mahseer comprises mainly 'brood' and 'spent' fish, caught during ascending and descending phases of migration respectively. The mahseer catch in other river systems comprises mainly the juveniles. It has been reported that there has been a general decline in the mahseer fishery due to indiscriminate fishing of brood fish and juveniles and the adverse effects of river valley projects.

37.2.16 The mahseer are known to have favourite angling qualities, similar to those of trout, except that there is difference in the quality of the flesh. In fact, the mahseer have additional quality of growing to much larger sizes which could make them more attractive as sport fish. Inspite of this the mahseer has not received as much attention in India as the exotic trout. The scientific management and conservation of fishery resources of mahseer in the country would, therefore, go a long way in promoting the tourist industry. There is also a possibility of mahseer attaining world popularity as a sport fish, which may give rise to a demand for their introduction in other countries. It is necessary to build up scientific data on the ecological and biological aspects of this category of sport fishes.

37.2.17 Considering the importance of the mahseer fisheries both for commercial and sport fishing, we recommend that extensive surveys and detailed ecological and biological investigations should be undertaken in the States, which are endowed with rivers and streams sustaining good mahseer populations.

37.2.18 Snow-trout fishery: This indigenous fishery consists of the various species of the genera *Schizothorax* and *Oreinus*, and is mainly prevalent in the streams and lakes situated in the Himalayas at altitudes ranging from 1,400 to 4,000 metres. Fishing is generally undertaken by cast nets. It has been reported that after the introduction of the mirror carp, *Cyprinus carpio var specularis* Lac., the indigenous fishery of the snow-trout has been considerably affected. This needs detailed investigations. The ecology and fishery biology of the species comprising the main fishery of the snow-trout should be studied with a view to improving the indigenous fishery. The Coldwater Fisheries Research Unit of the CIFRI has identified the localities for the collection of seedfish of snow-trout. It is, therefore, suggested that cultural possibilities of snow-trout should be explored by the concerned States in the waters of the western, central and eastern Himalayas.

3 RESERVOIR FISHERIES

37.3.1 Considerable importance has been given in the Five Year Plans to the construction of reservoirs which are impoundments on rivers so as to form artificial lakes. These reservoirs are primarily meant for irrigation and the generation of electricity but along with these the stored water has been put to various other uses—domestic and industrial. These man-made lakes constitute new and extensive areas for inland fishery development. It has been estimated that nearly 3.0 million hectares of waterspread area are available in this way. Based on the average yield varying from 5 to 8 kg/ha, the fish production from the reservoirs can reasonably be assumed to be about 20,000 tonnes. It could, however, be several times more. A yield of about 40 kg/ha has been achieved in the USSR, the USA and in some of the Indian reservoirs. This indicates that the reservoirs in India have a high potential for inland fish production.

Reservoirs in Planning Stage

37.3.2 The consideration of usefulness for fisheries, of most of the reservoirs already constructed, came only after the impoundments had taken place. The requirements from this point of view, however, need to be examined right from the initial stage of planning the projects so as to derive the maximum benefits.

37.3.3 The impoundments on rivers bring about an ecological transformation for developing fisheries from riverine habitat to lacustrine or reservoir conditions, with accompanying changes in physical, chemical and biological factors. The riverine fish population generally comprises a wide range of species, requiring still waters to flowing conditions. The species, which would find the lacustrine conditions more favourable, would thrive under the habitat of a reservoir, and would constitute the initial fishery of an impoundment. There would be a need, therefore, for undertaking hydrobiological surveys of rivers under impoundment by the Fisheries Departments with a view to determining the types of riverine fisheries which would thrive in the new reservoir conditions and the relative abundance of the concerned species. Such a study on the prospects for natural fishery of reservoirs would form the basis in determining the requirements for planning development of fisheries in them.

37.3.4 The clearance of obstructions, such as trees and high tree stumps from a reservoir basin, which would otherwise limit efficient fishery operations would be necessary prior to the first filling of the reservoir. It has been a matter of common experience that the contractors detailed for clearing trees from the reservoir area do not remove them where it is uneconomical to them. Felling of all trees flush with the ground and their removal must be ensured from the areas where fishing would be carried out.

37.3.5 Natural breeding and recruitment of desired species of fishes, either constituting the prospective natural fishery of a reservoir or to be introduced to enrich the reservoir fishery, are important biological considerations. With the prior knowledge of substrate requirements for the natural breeding of such fishes, the reservoir basin, prior to the first filling, affords an opportunity for any habitat improvement for spawning.

37.3.6 The Indian major carps, viz. *catla, rohu* and *mrigal,* occupy the most important place in the reservoir fish production. These fishes should either be the constituents of the indigenous fishery of a reservoir or be stocked therein so as to enhance fish production. Considering that indigenous fisheries in most of the reservoirs predominantly comprise predators such as *Wallago attu* (Schn.), *Mystus* spp., *Channa* spp. etc. trash fishes such as *Ambassis* spp., *Oxyqaster* spp., *Barilius* spp. etc., and several species of minor carps the stocking or 'planting' of major carps fingerlings would be an essential feature of such fisheries. Stocking would yield maximum benefits only when the major carps eventually become a part of the natural fishery of a reservoir i.e. the fishes attain the phase of natural breeding for self-recruitment. The following examples of reservoirs indicate how the stocking of major carps and their subsequent breeding have given rise to increased fish production:

Name of the reservoir (State)	Stocking of major carps yes/no	Breeding of major carps yes/no	Yield (kg/ha)
Tungabhadra (Andhra Pradesh)	yes	no	5.7
Tilaiya (Bihar)	yes	no	3.5
Bhavanisagar (Tamil Nadu)	yes	yes	35.9
Stanley (Tamil Nadu)	yes	yes	46.0

With a heavy demand of seedfish of major carps for fish culture in ponds and tanks, and overall deficit of seedfish production in general, it can be expected that the reservoirs have either been understocked within the range of 2 to 150 fingerlings per hectare as against the required stocking intensity of 500 fingerlings per hectare or the stocking has yet to be undertaken. In the circumstances, it would be necessary to establish a seedfish farm of a suitable capacity to produce enough fingerlings for stocking the reservoirs. The stocking of major carps should start right from the first year of an impoundment because the reservoirs have the highest phase of plankton productivity in the initial years, owing to enrichment of water with nutrients from large scale organic decomposition of the plant and animal matter submerged, and from the leaching effect of the inundated soil. Such a high productivity phase of a reservoir is very opportune for establishing the major carp fishery. This emphasises the necessity of planning a seedfish farm in the initial stage of the reservoir project. Consequent upon the natural breeding of major carps in the reservoirs, it may be thought that the seedfish farms would be rendered defunct as no more stocking of the reservoirs would be required. Inspite of this, the continuance of seedfish farms would be necessary. It has been observed that in the reservoirs where natural breeding takes place, there is a colossal destruction of fertilised eggs affecting considerably the recruitment intensity in the reservoirs. This would necessitate undertaking the salvaging of fertilised eggs on a large scale for subsequent hatching and rearing to fry and fingerling stages at the fishseed farms for stocking the reservoirs latter. These operations would be useful for getting higher yields of fish as well as for distribution for fish culture purposes in ponds and tanks. Thus stocking the reservoirs with major carps would not only be beneficial by giving higher fish production but would also be useful in supplementing seedfish production.

Existing Reservoirs

37.3.7 Considering that some of the reservoirs with established fishery of major carps yield around 40 kg/ha, it would be possible to increase production from 20,000 tonnes to 120,000 tonnes if carp fishery were established in the existing reservoirs with a waterspread of about 3 million hectares. This would be quite a task. But the efforts have to be progressively expanded in the direction of achieving this target. It would initially involve on the part of the State Fisheries Departments to classify the various reservoirs into

(i) those having established major carp fishery,
(ii) those which have been stocked but fishery has yet to be established, and
(iii) those which are unstocked.

37.3.8 It has come to our knowledge that in some of the States, the authorities controlling the reservoirs exclusively meant for domestic water supply do not allow fishing because of the fear of possible contamination. On this account, the development of fisheries is also not permitted in such reservoirs. But the exploitation of either the indigenous fishery which is already there in all the reservoirs or the developed fishery by operating gears such as gill-nets could be undertaken without causing any deterioration in the quality of the water. Operations would be safe from health point of view in storage areas prior to treatment in the purification tanks. We recommend that the authorities controlling such reservoirs should see that the potential fishery wealth of the reservoirs storing water for domestic supply is properly utilised without bringing about any deterioration in the quality of water.

37.3.9 The natural breeding of major carps in reservoirs is the most important factor in the context of increasing fish production. Failure of this would involve stocking as a continuous phase just as in the culture fishery of ponds and tanks. This may be possible in case of minor reservoirs, but it would not be advisable to follow this practice in case of medium and major reservoirs. Amongst the reservoirs already stocked, there would be several in which breeding has yet to take place and others in which breeding may not take place at all. There is no precise information available on the time lag between the first stocking and the initial natural breeding of major carps. The indications are that in the case of most of the reservoirs such time lag extends to a decade, though *rohu* and *mrigel* attain maturity in the second year and the *catla* in the third year. No detailed investigations have been made on the factors establishing the natural breeding in a reservoir. Major carps take a long period in acquiring acclimatisation for natural breeding. It should, therefore, be ensured that adequate level of water in the dead storages of medium and minor reservoir is maintained to keep the continuity of acclimatised stocks, as otherwise fresh stocking and acclimatisation would mean waste of effort and loss of time. It is, also suggested that ICAR should support investigations on natural breeding of major carps in reservoirs so that it becomes more widespread and takes shorter periods for acclimatisation.

Fishing

37.3.10 Fishing in reservoirs is mainly carried out by operating gill-nets of entangling types i.e. without the use of foot ropes. Besides, other types of gears such as dragnets, cast-nets, traps, lift-nets etc. are also used. Feeling the need for more effective exploitation of reservoirs, two FAO Inland Fishing Gear experts undertook investigations in some of the reservoirs under FAO/UNDP Programme during 1959-61 and 1962-64. They recommended various improvements to the fishing techniques in Indian reservoirs such as introduction of frame-net (a variety of gill-net with additional vertical line), improved set of gill-nets, etc. Some encouraging results have also been obtained by the Central Institute of Fisheries Technology (CIFT) by operating gill-nets of different colours. Inspite of these developments, there has been no appreciable change in the field practices probably because of the lack of necessary extension work. It is, therefore, suggested that the necessary etxension service should be organised by the ICAR by holding practical demonstrations of improved fishing gears and bringing out extension literature in co-ordination with CIFT and CIFRI.

37.3.11 In the case of reservoirs having abundance of undesirable fishes such as predators and trash fishes, it would be desirable to reduce their population as much as possible in order to improve productivity of major carps. The fishing effort specifically for the removal of undesirable fishes should, therefore, be intensified.

37.3.12 Fishing for major carps has to be rationalised as follows :

(i) The major carps are known for their shoaling movement during the breeding season when they are easy to capture. This has led to large scale indiscriminate killing of breeders near a number of reservoirs. It would, therefore, be desirable to enforce closed season in this period so that there is successful breeding and recruitment.

(ii) In case of reservoirs where breeding has not taken place, fishing for major carps should commence at least three years after the initial stocking. The intensity of exploitation has to be in proportion to the stocking intensity every year with a view to conserving adequate stocks for eventual natural breeding.

(iii) Selective fishing for only large sized individuals of major carps, by operating gill-nets of wide mesh, has been reported from some of the reservoirs such as Rihand, Bhavanisagar and Konar where mainly *catla* in the range of 15-20 kg in weight are caught. Such a practice tends to reduce the overall yield of a reservoir because allowing the fishes to grow to such large sizes would mean the consumption of biomass as food, more for mere maintenance of life than for the growth. The ideal condition for maximum yield in a reservoir would be to bring the stocks of different fishes to their average size/age where the growth rate would be maximum implying the optimum physiological utilisation of ingested food. It would, therefore, be desirable to spread the fishing pressure on all size groups in an endeavour to get the maximum yield per recruit.

37.3.13 In calculating yield per hectare, surface area in some cases is taken at the Full Reservoir Level (FRL) and in others the average area between the FRL and the Dead Storage Level (DSL). For uniformity, the average area between FRL and DSL should be considered for calculating the yield/ha.

Green Manuring

37.3.14 After the initial phase of high productivity, reservoirs generally decline in productivity as they increase in age. Enriching reservoirs with manures or fertilisers would then be uneconomical because of the annual draw down of water. This drawdown, however, exposes considerable portions of reservoirs in the summer months. This would result in the availability of extensive area of foreshore. These vast areas, while they still hold some soil moisture, could possibly be utilised for growing short duration summer legumes, which would enable the fixation of nitrogen in the soil and would also serve as green manure. The top cuttings of such legumes could be used as green fodder which is in short supply in summer months. However, the engineering authorities in-charge of reservoirs would not desire the soil to be disturbed by ploughing. This condition would limit the legumes to be of such types which could be grown either by merely broadcasting seeds or by superficial ploughing considered permissible. Fisheries organisations may, therefore, explore the possibilities of growing suitable types of legumes in the exposed portions of the reservoirs during summer months to enrich the reservoir productivity and, incidentally, obtain green fodder in the form of top-cuttings.

4 DERELICT FRESHWATER FISHERY RESOURCES AND THEIR RECLAMATION

37.4.1 The freshwater fishery resources, which have progressively gone into dereliction, comprise the ox-bow lakes, locally known as *mans* in Bihar, *beels* in West Bengal and Assam and *jheels* in Uttar Pradesh. These are long, narrow and bent courses of waterspreads which were formerly beds of river or streams which have changed their courses. Most of these waters have connecting channels with nearby flowing rivers or streams allowing entry of adult fishes and seedfish, including major carps, during the floods. They also receive rain water from the surrounding catchment areas. Some of the ox-bow lakes, which have no link with streams, receive water, fish and seedfish through extensive low lying areas nearby which get inundated during floods. These self-stocked resources function as capture fisheries yielding fairly good quantity of fish in the initial years. But the progressive siltation and blocking of the mouth and the connecting channels, prevent free flow of water into the adjacent agricultural land. The raising of embankments as a measure to prevent floods, has added to the isolation of these naturally stocked waters. Their continued neglect for several years has resulted in extensive growth of aquatic weeds, transforming them into extensive swampy areas. In West Bengal, the jute-retting carried out in such waters has further deteriorated the condition of fisheries in the *beels*. Most of them are, therefore, lying in derelict or semi-derelict state, yielding only small quantity of fish. Developmental measures, such as deweeding, desilting, restoration of the connecting channels and stocking them with fingerlings of major carps, have been undertaken in some of these derelict resources. These measures which merely restore the original capture fishery are not adequate to exploit their potential for intensive fish culture.

37.4.2 These swamps, varying in depth upto 10 metres in the central zone with shallower margins of considerable extent, have adequate water for several months during the year. The shallower margins would be suitable for reclamation into smaller fish farm ponds. In this context, it has already been pointed out that there are not many freshwater resources now available in the country exclusively for undertaking intensive fish culture on lines similar to culture experiments of composite carps which have yielded around, 8,000 kg/ha. To create such small units at other freshwater areas may involve conflicting of water use. These derelict waters, therefore, offer excellent opportunities for the construction of small ponds, providing occupation to several fish farmers. The possibility of constructing similar freshwater fish farming ponds also exist in the larger type of swampy areas i.e. the lake-like *beels* which are wide and shallow areas of low lying extensive waterspreads having inadequate drainage.

37.4.3 It has been indicated in paragraph 37.7.43 that the intensive culture of composite carps, when undertaken in the farm ponds of 04 ha each, can give an income of Rs. 2,500/-. The possibility of such favourable returns should adequately justify necessary developments for reclamation of derelict freshwater fishery resources. The reclamation would also involve the restoration of connecting channels and their mouths and the installation of sluice gates to regulate supplies of water and avoid inundation of neighbouring agricultural fields. These works will have to be borne on government account. The extent of derelict freshwater fishery resources is approximately 0.4 million ha of which only marginal areas constituting about 25 per cent or 0.1 million ha could be utilised for the construction of farm ponds. This would contribute 0.5 million tonnes of carp production to the inland fish production in the country in addition to the production available from the capture fishery of the central zone. With such prospects in reclamation of derelict freshwater fishery resources, the State Governments should consider these resources as exclusively fishery resources while considering the land and water utilisation policy, and other interests, if any should be deemed to be incidental to the fishery development.

5 ESTUARINE FISHERIES

37.5.1 Under the term estuarine fisheries is included the fishery output from the mouths of rivers, the large brackishwater lakes, the innumerable tidal creeks and backwaters along the coast and the coastal canal systems. Waters are saline but not of as high a salinity as seawater. In the rainy season, the brackish regions experience a sharp fall in salinity and not infrequently the waters become nearly fresh. Large lakes like Chilka and Pulicat even contain high saline, low saline and freshwater regions each with its own distinct fisheries. The estuaries and backwaters are highly productive areas because of enriched drainage from the land and influx of nutrients causing high primary and secondary production. The estuaries, as an ecosystem, undergo dynamic stresses, mainly brought about by salinity changes and other physico-chemical factors, due to varying intensities of freshwater discharges in different seasons and tidal fluctuations throughout the year. This often limits the availability of species of adaptable types. There are thus only a few species of high commercial value capable of being grown and cultured in these habitats.

37.5.2 Considering, in general, the conditions prevalent in the Indian estuaries, it has been observed that marine forms predominate in the fish landings and the fluctuations in their catches are related to migratory patterns as well as the interaction of the various environmental factors. There are no reliable estimates of total area and production from the estuarine resources. Data have been compiled by the CIFRI for the main regions of the estuaries, comprising Hooghly-Matlah estuarine system, the deltaic estuaries of the rivers Godavari, Krishna, Cauvery, Narbada and Tapti, the Chilka and Pulicat lakes and the backwaters of Kerala including Vembanad lake. It has been estimated that the estuarine waters have a spread of approximately 2.6 million hectares. The salient features including production, from capture fisheries of some of the important estuarine resources, are described below.

37.5.3 Hooghly-Matlah estuarine system: The area of this system is estimated to be about 0.8 million hectares. The tidal impact is felt upto about 290 km from the mouth. Although fishing activity, by a variety of crafts and gears, is observed round the year in the different regions, the winter fishery operations conducted during November to February in the lower Sunderbans account for the major portion of the annual landings which vary between 6,000—11,000 tonnes. It is estimated that 60 to 70 per cent of the total landings are caught in bag nets. The catch comprises mainly prawns (14-17%), *Hilsa* (14-22%) and Bombay duck, *Harpodon nehereus* (Ham.) (14-27%).

37.5.4 Mahanadi estuarine system: This system, in the districts of Cuttack and Puri in Orissa State, is characterised by poor tidal oscillations and flood discharges. The mouth of the main estuary is narrow, a factor which in combination with other morphological and flow characteristics, might have resulted in the development of sedimentation features such as spits and bars. Formation of these barriers which restrict the influence of the flood tides upto about 32 km only upstream is probably responsible for the short length of the estuarine belt. These characteristics are, therefore, reflected in the low potential of the fishery in this estuary. The estimated annual marketable surplus from the entire estuary varies from 500—900 tonnes, comprising mainly mullets, hilsa, bhetki and sciaenids.

37.5.5 Godavari estuarine system : The area of this system is about 18,000 hectares. In the Goutami, which is the main estuary of this system, the tidal influence extends upto 48 km upstream. The development of sedimentation in this system also restricts the entrance of neritic water from the sea. The total production from this estuary is estimated to be about 5,000 tonnes mainly composed of mullets and prawns.

37.5.6 Estuaries in Tamil Nadu: The total area of the estuaries in Tamil Nadu has been estimated to be about 0.15 million hectares. The total annual landings from these estuaries is estimated to be about 10,000 tonnes, the bulk being contributed by mullets.

37.5.7 Chilka lake : It is the largest lake in the country, having a waterspread of about 100,000 hectares, and is an important fishery resource of Orissa State. It is connected to the sea by a natural channel 24 km long and 350 metres wide in the north, and an artificial channel called, Ganjam canal, in the south. The salinity of the lake waters is influenced by the flood discharges from the branches of the Mahanadi system. Because of the general shallowness of the lake, with a maximum depth of only 3 metres during summer and 4.5 metres during monsoon, which makes the fishing operations very convenient, the lake is being exploited intensively. The fishing is mainly conducted by net-fishing comprising drag, cast and gillnets and trap fishing for prawns. The enclosures in low-lying region of the lake barricaded by split-bamboo screens, are leased out as janos fisheries. The annual production from the lake has come down from 4,700 tonnes in 1954-55 to nearly 3,000 tonnes during 1964-65 and 2,740 tonnes during 1970-71. The decline in production has been mainly attributed to the silting up of the lake and the channel and shifting of the mouth. The major fisheries of the lake are mullets and shrimps.

37.5.8 Pulicat lake : This lake, which lies in the States of Andhra Pradesh and Tamil Nadu, has a total area of about 77,000 hectares with a waterspread of only 37,000 hectares, the banks being mostly dry but becoming marshy during monsoon. However, the waterspread may increase due to drainage water from the surrounding agricultural lands which are being increasingly brought under irrigation. The lake is connected to the sea by a narrow mouth. Two seasonal rivers drain into the lake. The total annual estimated landings are about 11,000 tonnes comprising mainly prawns and mullets.

37.5.9 The fisheries of the brackishwater lakes, being dependent mainly upon the ingress and egress of larvae, juveniles and adult fishes and prawns, have been affected adversely by the progressive siltation of the connecting channels and their mouths. To improve the fisheries in the lakes, it would be necessary not only to restore but also to maintain in proper condition the connecting channels and mouths so as to ensure proper tidal flows. The lakes also receive freshwater drainage. As such, the inflow of freshwater and seawater into the lakes, and outflow of brackishwater from them, will have to be so regulated as to maintain the dual interest of improving the fisheries in the lakes and of crop production in the surrounding agricultural areas. It is, therefore, recommended that the concerned State Governments may formulate proposals for integrated development through a team of technical officers of Irrigation, Agriculture and Fisheries Departments.

37.5.10 Backwaters of Kerala: The backwaters of Kerala occupy about 50,000 ha, including the largest area of the Vembanad lake (26,000 ha). The total catch of fish and prawns from the backwaters is estimated to be 14,000—17,000 tonnes. The composition of the catch is prawn (60), mullets (11), pearl-spot (10), catfishes (9) and others (1%). Among the gears operated, dipnets and stake-nets are important, of which Chinese dip-net is mainly used for catching prawns during night with the help of petromax light and for catching mullets during the day.

37.5.11 General consideration: The estuarine resources of India include besides those mentioned above, the deltaic estuaries of the rivers Narbada and Tapti, and hundreds of coastal streams on east and west coasts, yielding highly valuable species of fishes and prawns. These constitute fisheries of appreciable magnitude, besides being the source of seed for brackishwater culture. As the marine forms predominate in the catches from estuaries, it is necessary that the parameters of migration of the commercially important fishes and prawns in and out of the estuaries are comprehensively studied. It has also been reported that estuarine fish stocks have been considerably affected by indiscriminate catches of large quantities of brood fish and juveniles and by restricted drainage from the river systems. With a view to developing capture fisheries on proper lines for increasing production, it is suggested that the States concerned should undertake necessary investigations on the estuaries within their jurisdiction. The methodology and guidelines developed by ICAR may be followed for adopting necessary conservation and management measures.

6 AQUACULTURE

37.6.1 Aquaculture includes all aspects of production of aquatic organisms in captivity, comprising either some or all stages of their life history and their live foods, and the resultant marketable products in the habitats of fresh, brackish and sea waters. The main role of aquaculture is its contribution to human nutrition, directly as production of food species and indirectly through the production of unicellular algae for use in animal feeds. In addition, it also serves the needs of recreation in the form of sport fishing, and yields pets or ornamental fish for home aquaria. Aquacultural practices also yield industrial products such as cultured pearls, marine colloids etc.

37.6.2 The technology of aquaculture, with its base rooted in the traditional practices carried out for several centuries in some of the countries, particularly in the Indo-Pacific region, has made considerable advances in the last two or three decades. This has led to a better understanding and appreciation of the potential of aquaculture and its role in the development and progress of fisheries. The limitations in production from the wild stocks alone, particularly of the preferred species, have further added to the importance of aquaculture in supplementing production of such species even in traditionally leading fishing countries. Aquaculture has thus assumed worldwide importance by giving increased production.

37.6.3 Considerable progress has been made in improving per hectare yield from ponds and tanks by employing principles similar to those adopted in crop production and animal husbandry. The most important component of aquaculture practices is the quality and quantity of 'seed' of fish and shellfish. Considerable success has already been achieved in producing seed by controlled breeding, spawning, artificial selection, nursing and rearing the young ones of several culturable species. Attempts are also afoot with regard to other species to obviate the limitations posed by collection of their seed from natural resources. The hatcheries have been considerably modernised with devices for controlling required factors in water supplies, such as temperature, oxygen, salinity, removal of metabolic wastes, prophylactic treatment to make water free of pathogens, etc. The illustrative examples are hatchery establishments for trout, salmon and oysters. Trout and salmon have long incubation periods of upto about five weeks depending upon the temperature of water. The fish hatcheries for large scale production of young ones of these fish resemble practices in the latest modernised hatcheries in the poultry industry. This has enabled the extension of trout culture from merely catering to the requirements for sport fishing to commercial production. The anadromous Pacific and Atlantic salmon spawn in the freshwater streams and reveal a high degree of parental care with the parents dying soon after. In these fisheries, artificial propagation is undertaken either by stocking young ones reared in the hatcheries or by creating new spawning streams or by the combination of these two methods. This is done to bring about improvements in the natural sea fisheries, which were found to be depleting due to considerable increase in fishing intensity following introduction of high sea fishing. Added to this there was deterioration brought about by the construction of dams and barrages, and the rapid rate of urbanisation. In the case of salmon, it has been shown that the aquaculture practices can enrich even natural sea fisheries.

37.6.4 Besides the modernisation of hatcheries, advances have also been made in the techniques for increasing marketable production by intensive methods. In developing these methods, advantage has been taken of the amenability of some of the species to economical artificial feeds, the extensive use of which has given rise to the ancillary industry of manufacturing such feeds. Advantage is also taken of the fact that aquacultural production is virtually non-consumptive of water, requiring it merely as living medium; this feature has led to undertake intensive production in confined spaces. The recent introduction of the technique of intensive production in small containers of fibre glass or other suitable materials, with recycling of water in conjunction with devices for manipulation of the relevant factors as in modern hatcheries, leads to the conservation of use of freshwater. The development of techniques for marketable production of fish and shellfish in floating cages and rafts of different materials and net enclosures of synthetic fibre, has opened up the possibilities of undertaking intensive aquaculture in a wide range of habitats. Japan, which has considerably advanced these techniques for increasing production has formulated rules and regulations for leasing out portions of its inshore seas to the fishermens' cooperative associations which, in turn, grant the use of specific areas to individual members. In other countries, the lack of similar provisions has proved an obstacle to the development of mariculture. Even ground culture of oysters which has proved considerably more advantageous and productive, cannot be practised by the farmers in important oyster producing countries. The utilisation of sewage and some of the other organic wastes, such as those from sugar and starch factories, breweries, dairies, etc. as organic manures for increasing productivity has been a progressive field of application in combating biologically some of the problems of water pollution. The use of heated water from the thermal power stations in the countries in the temperate region has enabled creating summer conditions for aquaculture all the year round. Lastly, in the field of mariculture, the inshore seas are being barricaded as 'pens' with sophisticated systems of fencing for retaining cultured organisms alone and to keep out others. This is, however, yet in an experimental stage. Thus, recent developments in the technology of aquaculture have considerably widened the scope for fish and shellfish production from fresh, brackish and sea waters.

37.6.5 Like other animals, fish reared under captivity conditions are prone to diseases caused mainly by bacteria, viruses and protozoa. The problem of fish diseases becomes more pronounced under intensive aquaculture practices. The therapy of fish diseases, which was little understood in the past, has made significant progress in recent years and many diseases can now be controlled by various treatments or by selective breeding of disease-resistant stock.

37.6.6 The organisation of aquaculture as an industry has been based so far on provision for subsistence of the farmers or giving them part-time occupation. In recent years, however, there has been a change in outlook towards production on commercial lines as small scale enterprises and large scale establishments on corporate basis. In fact, some of the larger commercial houses in the world have even committed their own resources as non-recoverable development capital for furtherance of research and development in aquaculture after objectively appraising the investment opportunities with a view to diversifying their production lines. The role of the Governments in promoting research and development programmes would depend upon the relative importance of aquaculture as a means of increasing production of fish and shellfish.

37.6.7 In countries like India with low per capita income, the policy of promoting aquaculture should not only lead to increased production, but should also provide maximum employment opportunities. There is need, therefore, for supporting research and development programmes including extension services and extending loan and credit facilities on easy terms.

7 CULTURE IN FRESHWATERS

Carp Culture in Existing Ponds and Tanks

37.7.1 Freshwater fish culture in ponds and tanks has been an age-old industry in our country, traditionally practised by empirical methods developed by the fishermen. Prior to Independence, fish culture was mainly confined to the eastern States of West Bengal, Bihar, Orissa and Assam. The network of rivers in these States contained a higher percentage of spawn of major carps viz. *catla, rohu* and *mrigal* which were esteemed as table fish and were cultured because of their rapid growth. They feed on food available in the different ecological niches in confined waters. The methods developed were to make large scale collections of spawn from the rivers during the summar monsoon months, and to rear the spawn to fry stage in fish nurseries. The sale of spawn and fry developed as an organised industry, mostly in West Bengal, with the main trading markets at Sealdah and Howrah, near Calcutta.

37.7.2 Fish culture activities for increasing production, received impetus during the Grow More Food campaign and the Five Year Plans. Under the plan schemes, freshwater fish culture was extended to all the States. The programme thus developed into bringing every year as much area of culturable water resources as possible under major carp culture by stocking the seedfish in whatever quantities that were available both by procurement from Calcutta and by production within each State. On the basis of information furnished by the States to this Commission, the culturable waters comprise an area of about 1.5 million hectares, out of which 1.0 million hectares were brought under culture by 1972.

37.7.3 The rate of stocking seedfish in production units, considered in terms of fry stage, varies in different sizes of waterspreads viz. upto 2 ha, 2-10 ha, 10-200 ha and 200 ha and above. The different rates of stocking intensity in these categories as practised in the States, and the corresponding stocking intensity suggested[1] are given below:

Category (ha)	Stocking intensity practised in the States	Stocking intensity suggested by the Fish Seed Committee
up to 2 ha	2,500	6,000
2—10 ha	500-2,500	5,000
10—200 ha	100-500	2,500
200 ha and above . . .	below 100	1,000

The aforementioned comparison clearly indicates that the stocking rate of seedfish in different categories of confined freshwaters has been considerably low. This has been attributed to the shortage in the availability of seedfish.

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[1] 1966. Report of the Fish Seed Committee :11 New Delhi. Department of Agriculture Government of India.

37.7.4 The understocking of seedfish would reflect the low fish production from confined waters. The yield per hectare so far attained from the various categories of waters is given below:

Category	Yield (kg/ha)
upto 2 ha	750-1,000
2-10 ha	500-750
10-200 ha	upto about 200
above 200 ha	upto 100

The aforementioned levels of yields are obtained without the use of manures, fertilisers, and supplementary feeds.

37.7.5 During the last 25 years, several advances in fish cultural practices have been made, particularly as a result of researches conducted by CIFRI. Improvements over the traditional system of transporting seedfish in earthenware and metal containers by introducing the method of packing seedfish in plastic bags filled with water and oxygen made transport of seedfish even by air economical. This packing-transport method was responsible for the extensive spread of carp culture to distant parts of the country. The success in breeding the major carps under captive conditions by hypophysation has been an outstanding contribution in the methods of seedfish production. The management practices with regard to rearing of spawn and fry have also been considerably improved.

37.7.6 Improved technology in fish culture should eventually lead to the maximisation of fish production per unit water area. Fish production is influenced by different factors viz.

- (i) soil nutrients and the quantity and quality of water, contributing to the production of plankton, nekton and benthos which form natural foods for fish,
- (ii) manures and fertilisers for augmenting the biological production of natural foods,
- (iii) supplementary or artificial feeds which are directly consumed by the growing fish, and
- (iv) the population balance of different types of seedfish to make the most efficient use of all types of foods, produced and introduced.

The inputs, comprising manures, fertilisers, artificial feeds and seedfish, constitute an important set of factors, as these can be so adjusted as to make the best use of the 'holding capacity' of water for maximum fish production. Systematic knowledge of the effects of inputs on maximising fish production is beginning to accumulate all over the world, including India.

37.7.7 The present practices of input application comprise only stocking of seedfish, and that too not in adequate quantities and suitable composition to make the best use of natural foods. To increase per hectare yield, the CIFRI conducted cultural experiments on major carps by utilising different inputs such as manures, fertilisers and artificial feeds. in farm-ponds of upto about 0.4 hectare. The results so far obtained have shown a production capacity of about 3,000 kg/ha.

37.7.8 The effective utilisation of inputs, particularly the supplemental feeds, with major carps alone in the cultural experiments, did not yield desired results. Further work was, therefore, necessary to find out suitable direct feeds for major carps. Experiments were undertaken on composite carp culture, combining major carps with three species of exotic carps introduced into India from the East Asian countries. These were the Bangkok strain of common carp (*Cyprinus carpio*) introduced in 1957, and the silver carp (*Hypophthalmichthys molitrix*) and the grass carp (*Ctenopharyngodon idellus*) both introduced in 1959. The silver carp feeds mainly on phytoplankton, which is the basic element in the food-chain, and as such, this fish can make the most economical use of manures and fertilisers. The grass carp shows rapid rate of growth when fed on aquatic weeds and land vegetation such as grass; it can, therefore, be grown where these specific feeds can be made available in large quantities. Common carp is an omnivore, utilising a large variety of supplemental feeds most efficiently. It breeds easily in captivity almost throughout the year, thus easily providing the seedfish for raising more than one crop a year. By taking advantage of the feeding habits of these exotic carps, the experimental trials on composite carp culture have given a yield of about 8,000 kg/ha. The stocking intensity of seedfish in these trials comprised 5,000 fingerlings (or 10,000 fry) per hectare.

Seedfish

37.7.9 Seedfish is the most important component for fish culture. On its stocking density depends the desired quantities of other inputs such as manures, fertilisers and artificial feeds to obtain optimal yield per hectare. The production rates of about 3,000 and 8,000 kg. per hectare, in case of major carps and composite carps respectively, have been obtained in experimental cultures with the stocking intensity of about 10,000 fry per hectare. It has already been stated that the prevailing shortage in seedfish availability has been responsible for practising stocking rates which are considerably lower even than those suggested by the Fish Seed Committee. In this context it would be necessary to have an idea of the magnitude of this shortage. We may consider all the available culturable resources under two categories of production units, viz.

(i) those below 10 ha, and
(ii) those above 10 ha

since some of the States did not furnish information on all the four categories as required. The estimated requirements of seedfish (fry) on the basis of 5,000 and 1,000 fry per hectare respectively is shown in Table 37.1. These are on the low side of the suggested stocking densities.

TABLE 37.1

Seedfish (Fry) Requirement for Stocking Available Culturable Rsources

Category	Area under fish culture (million ha)	Area to be brought under fish culture (million ha)	Total (million ha)	Stocking density (No. of fry/ha)	Total fry requirement (million)
upto 10 ha . . .	0.24	0.16	0.4	5,000	2,000
above 10 ha . . .	0.76	0.34	1.1	1,000	1,100
total . . .	1.00	0.50	1.5		3,100

It is seen from the table that approximately 3,100 million fry would be required for stocking 1.5 million ha of the available culturable resources on the basis of conservative stocking densities. The Ministry of Agriculture and Irrigation has estimated[1] that the production of fry by the end of the Fourth Plan reached nearly 500 million. Thus there would be a shortage of about 2,600 million fry for adequately stocking the available culturable resources. Besides this, an additional quantity of 3,000 million fry would be required for raising into fingerlings for stocking the available area of nearly 3 million ha of reservoirs or man-made lakes. In addition to the aforementioned requirements, further quantities would be required for stocking the resources which would be created in the next 25 years and for undertaking intensive fish culture. Thus alongwith improving fish culture in ponds and tanks by increasing the stocking density, the foremost consideration will have to be given to the methods of intensifying seedfish production in the country.

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[1] 1974. Statistical supplement. Ninth Meeting of the Central Board of Fisheries : 43. Ministry of Agriculture, Government of India.

37.7.10 The seedfish, in the form of spawn of major carps is obtained by four methods—(a) Riverine sources; (b) Wet bunds; (c) Dry bunds; (d) By Hypophysation.

37.7.11 Riverine sources: During summer monsoon, the grounds adjoining the river banks get inundated with the overflow of flood waters. Such grounds are conducive for the major carps to breed. Subsequently, the receding floods help the spawn to go down from these grounds to the rivers. The spawn-nets are fixed in the downstream of rivers in suitable stretches where the current velocity is favourable for collection. The commercial exploitation of spawn collection is, however, confined to those stretches of rivers where either the resident or the migrant population of major carps is fairly large. Besides, the collection is limited only to the days on which the spawn of major carps is found to be in much greater percentage than the spawn of several other fishes which also breed in the monsoon season. As the traditional centres for spawn collection established by the fishermen were not adequate to meet the growing need for seedfish, prospecting of rivers for locating new centres was undertaken first by the CIFRI alone, and then in collaboration with the State Governments, leaving the choice of rivers and areas to the States to suit their developmental needs. These investigations resulted in locating some new spawn collection centres, but several others did not have the desired percentage of spawn of major carps. The riverine sources contributed about 90 per cent to the total quantity of spawn required to be reared as fry and fingerlings for stocking the culturable resources in the country.

37.7.12 The prospects for any substantial increase in the supplies of spawn from the riverine sources do not seem to be good. Firstly, the prospecting investigations for locating new spawn centres have given indications of only marginal increase in supplies. Secondly the rivers are progressively being affected by flood control measures, commissioning of various river valley projects such as irrigation or multipurpose reservoirs, discharge of effluents and domestic sewage and indiscriminate fishing of breeders. It is apprehended that even the maintenance of present supplies, which is of considerable importance, may become increasingly difficult. It has been reported that there has been a fall in the quantity and quality of spawn from some of the established regions. As such, to maintain the spawn wealth in the rivers, it would be necessary to undertake conservation measures. The spawn collection centres and breeding grounds of major carps have to be identified and declared as sanctuaries by the respective State Governments.

37.7.13 Wet bunds: These are perennial confined waters such as larger tanks and reservoirs where natural breeding of major carps takes places. As the breeding generally occurs *en masse* on a single day, this phenomenon should be watched for from the very commencement of the monsoon. By locating the breeding grounds, millions of fertilised eggs can be collected. This collection has to be done within a span of a few hours i.e. after the eggs have become water-hardened and before they hatch. The eggs have to be reared upto the spawn stage in the cloth enclosures or *hapas* at the wet bund itself, as the eggs are too delicate to be transported. Difficulties originally experienced in using fixed *hapas* have been obviated by replacing these with the floating ones, so as to take best advantage of natural breeding. If the eggs are not collected but left to nature, not only will large losses take place as eggs but even in subsequent developing stages through the agency of other fishes. Thus, by salvaging the fertilised eggs and by rearing them to further stages, not only the pure seedfish of major carps could be used for stocking other culturable resources but the seedfish could also be used for stocking the wet bund itself. This would be a better management practice for increased fish production from reservoirs.

37.7.14 Though large number of perennial tanks and reservoirs have already been stocked with major carps, fertilised eggs are being collected only from a few wet bunds. The others might be classified into one or the other of the following categories :

(i) Wet bunds yet to be determined — Breeding may be taking place, but it is still to be observed.

(ii) Potential wet bunds — Breeding has still to take place in course of time.

(iii) Unsuitable wet bunds — Topographical conditions, rain water additions and other requisite factors may not be congenial to breeding. If the factors responsible are determined, conditions can be provided to convert some of the unsuitable resources into wet bunds.

37.7.15 Considering that a large number of perennial tanks and reservoirs are already stocked with major carp and their number is progressively increasing every year, in the programme of stocking culturable resources with major carps, wet bunds will assume added importance for increasing supplies of seedfish. The State Governments have to intensify their investigations to locate as many wet bunds as possible for increasing seedfish production. The ICAR should undertake detailed investigations in collaboration with the States where wet bunds are being exploited to find out the factors responsible for the success of the natural breeding of the major carps in the wet bunds.

This would help in bringing about breeding in as many perennial resources as possible by providing the necessary conditions.

37.7.16 Dry bunds: The characteristic seasonal ponds of rain water and overflowing drainage in which the introduced major carps breed soon after the rains, are called dry bunds. Production of seedfish by this method has been traditionally carried out in Bankura and Midnapore districts of West Bengal. This method with improvements by providing dam, overflow and drainage arrangements for repeated use of each dry bund during monsoon, has been adopted mainly in Madhya Pradesh. There are certain limitations in adopting this method such as the requirements of specific topography i.e. undulating terrain, high cost of construction and maintenance of dams and irregularities experienced in breeding. Despite these limitations, the adoption of this method deserves greater attention because of the necessity of intensifying seedfish production by exploiting all possible natural resources. The States should undertake surveys for finding out suitable areas where dry bunds can be constructed with minimum cost.

37.7.17 By hypophysation: First success in India in inducing the major carps to breed under captivity by giving injections of pituitary extract was achieved in 1957 by the scientists at the CIFRI. Since then, this method has been increasingly adopted in the States by establishing seedfish farms, as it has distinct advantages over the other methods. Not only it gives pure quality of spawn as in wet bunds and dry bunds, but this method also affords the facility of regulating the composition of major carps as desired, because each species is bred separately. By establishing the seedfish farms nearabout the complex of culturable waters, or by breeding the fish at stocked water resources, this method is apt to bring about reduction in the cost as well as workload in the system of transport and distribution of seedfish. It also provides an opportunity for improving the quality of seedfish by selection and hybridization.

37.7.18 The capacity of Seedfish Farms developed in the States is enough to produce only about four per cent of the total seedfish production. Considering the advantages of spawn production by hypophysation, it would be advisable to establish as many seedfish farms as possible to attain self-sufficiency within each State or at least within a geographically related and well connected region.

37.7.19 Possibilities of establishing such farms exist mainly at medium and major irrigation reservoirs, multipurpose projects and reservoirs for supply of drinking water which can meet the demand for perennial supply of water to the farms. It is estimated that the waterspread area of about 1.5 hectares of such a farm can produce about 5 million fry per annum. The estimates of economics of seedfish production by this method is given in Appendix 37.2. Additional area will be required for the construction of bunds, laboratories, staff accommodation, store rooms, etc. The exact area for each seedfish farm will depend on the quantity of seedfish required for stocking the reservoir itself and the extent of culturable area of water resources within a radius which does not involve long-distance transport problems. Such seedfish farms have to be constructed at the sites near the reservoirs or in the upper reaches of the canals, because in the off-season when the crops do not need water, the water in the canals may not have to be run for supplying seedfish farms only, which is an avoidable waste of water.

37.7.20 It is, therefore, suggested that States should intensify the programme of seedfish production through induced breeding by pituitary injections or other substitutes. As a perennial supply of water to seedfish farms would be an important requisite, location of such farms should preferably be near the reservoirs. Suitable land for construction of seedfish farms should be made available to the Fisheries Departments on preferential basis.

37.7.21 The information furnished by the States also reveals that whatever little capacity of seedfish production by hypophysation has been developed, there has been considerable shortfall in spawn production. This has been attributed mostly to insufficiency of pituitary glands and inadequate rainfall during the breeding season.

37.7.22 Shortage of pituitary glands experienced even at the present level of activity of spawn production by hypophysation will further aggravate when this activity is organised on a much larger scale. The main reason for this shortage is that the technology in this method has not advanced much. The pituitary extracts are still being prepared by using fresh or preserved pituitary glands of major carps which mature only once a year. The glands are collected from mature fish two or three months prior to monsoon or during the monsoon. Some relief can be expected by collecting the glands of common carp which, unlike major carps, attains maturity almost throughout the year. This fish is being bred in increasing quantities in almost all the States. Greater relief can, however, be expected when suitable substitutes are brought into use. Although some experiments using various types of substitutes, either singly or in admixture with fish pituitary extracts, have been conducted all over the world, including India, no tangible results have been obtained for field application. It is also reported that some success in biological characterisation of fish pituitary extracts by fractionation has already been achieved by the CIFRI and some of the Universities in India, in breeding catfish and major carps. But to determine the specificity of the hormones responsible for the success of induced breeding, the fish gonadotropins have to be isolated and studies made on their biochemical characterisation and the physiological changes brought about by them in the injected fish. The intensification of research in this direction will help in finding suitable substitutes. Very important work in this direction is going on at the Zoological Laboratory of the University of Sorbonne, Paris, under Professor Fontaines, where much success has been achieved in separating the major elements in the pituitary and thyroid extracts of the eel. It is, therefore, essential that priority consideration should be given by ICAR to the intensification of research on fish gonadotropins at the CIFRI, which, in turn, may seek the necessary collaboration with universities and pharmacological laboratories where similar type of work is being undertaken.

37.7.23 The necessity of favourable environmental factors, even after pituitary extract injections are given, has indicated that the role of pituitary extracts is only complementary. It is also because of the dependence on environmental factors that the receptivity phase of major carps towards these injections, giving maximum frequency of success in spawning, is confined to only three weeks or so during the monsoon. The length of this period varies in different regions in the country. Some studies on the effects of temperature and daylight on the processes of maturation and breeding have been carried out by the CIFRI and some of the universities. The work on correlation with rainfall has been comparatively lacking presumably because rain gauges have not been installed at the fishseed farms. It is, essential, therefore, that the studies on the effects of the environmental factors by themselves and in combination with the pituitary extracts, should be intensified by the ICAR in coordination with the universities where similar work is being carried out, with a view to eventually providing necessary factors under controlled conditions for attaining a better frequency of success in induced breeding of major carps.

37.7.24 Seedfish (fry): The spawn (about 8.0 mm length) is grown to fry (20-25 mm) in fish nurseries in small ponds. This takes about 10-15 days. Improved practices in fish nurseries have made it possible to nurse spawn at the rate of 6.0 million/ha giving at least 50 per cent survival of fry. In some States this intensity is only 2-3 million spawn/ha while in others it is still lower. Even with such low rates of nursing spawn, the survival of fry is reported to be less than 50 per cent. The understocking of spawn results in the wastage of nursery space, and the high mortality lowers the resulting production of fry. It is, therefore, essential to give effect to improved management practices in fish nurseries so that States can adopt such practices. The

ICAR should organise training the demonstrations in fish nursery management for adoption of improved practices in the States and bringing out relevant extension literature.

37.7.25 Lack of adequate nursery space has also been the common experience of almost all the States. This situation arises when large quantities of spawn are to be handled, particularly consequent to wet bund breeding on a single day or during the peak period of induced breeding by hypophysation. It would be necessary, therefore, to increase the ground nurseries so as to meet growing needs as the activity of seedfish production increases. It may also be worthwhile to explore the possibility of establishing floating nurseries wherever there is necessity for economising ground space. Such floating nurseries will be of particular advantage in nursing separately different batches of spawn produced by induced breeding at different intervals. Mixing the batches of spawn of the same species is not advisable because of consequential difficulties in separating developed fry for disposal, or for making required compositions for distribution. Incidentally, such floating nurseries will also enable the rearing of spawn at the production units as and when induced breeding is adopted by the fish culturists. This will not only economise on the space requirements for providing separate ground nurseries, but will also obviate the need for the effort for netting out fry for which separate fry-nets have to be maintained. Such floating nurseries can be made from fabrics of synthetic material. It is, therefore, suggested that ICAR should examine the possibility and economic feasibility of establishing floating nurseries as an additional facility.

37.7.26 Seedfish (fingerlings): Direct stocking of fry in production units, which are not rendered dry to eradicate predators is sometimes wasteful to such an extent that there is hardly any production. Fry has, therefore, to be grown to fingerlings stage (about 120-150 mm in length) in rearing ponds. This will take nearly 2-3 months. With improved techniques, it has been possible to achieve a rearing intensity of 100,000 fry/ha with 75 per cent survival of fingerlings. Although it is advisable to stock fingerlings in production units, their rearing and distribution is beset with problems. The State Directorates of Fisheries have been experiencing difficulty in acquiring adequate space even for fish nurseries. It will be still more difficult to get much larger space required for rearing ponds. These difficulties, which are being experienced at the present level of seedfish production, have also to be taken into account in the perspective of increasing the seedfish production considerably. Besides the distribution of fingerlings as compared to fry is more costly and is accompanied by more mortality in transit. As such, rearing of fry to fingerlings as far as possible has to be undertaken nearabout the fish production units. At most of these units, rearing facilities are not available. It is, therefore, considered that facilities should be created wherever necessary including preferential consideration by Government in allocating fallow lands near the production unit for construction of rearing tanks. The situation will also require the need for an alternative method. The ICAR should examine the possibilities of rearing fry to fingerlings in floating net enclosures and also make a study of the requisite artificial feeds and the economics of the method.

37.7.27 Seedfish of exotic carps : Of the three types of exotic carps, the production of seedfish of the common carp, poses no problem as this fish attains maturity and breeds throughout the year under all captivity conditions. Besides, this species has established itself well in all the States and is being bred in increasing quantities. It is the mass production of the seedfish of grass carp and silver carp which has been quite a problem in various States. They seem to require different methods of handling. Although these two species of fishes, like the major carps, attain maturity only once a year and can be breed by hypophysation, they do not breed naturally in cloth enclosures or breeding *hapas*. As such the injected males and females have to be stripped at the proper time *i.e.* a few hours after the injection, for breeding *hapas*. As such the injected males and females have to be comparatively more wasteful, resulting in lower rate of spawn production. The method also requires a fair amount of skill.

37.7.28 The first consignment of seedfish of grass carp and silver carp was imported into the country in 1959 and the fishes were breed for the first time in 1962 at the fish farm of the Pond Culture Division of the CIFRI at Cuttack. Thereafter, small consignments of seedfish of silver and grass carps were sent to different States for constituting a basic stock for further production of seedfish. In several States, however, these fishes did not thrive well as such the basic stock has still to be established. In the States, where some of the fish thrived well, these have been continuously bred since then but the stocks at the seedfish farms have not yet developed to produce enough seedfish for distribution for undertaking composite carp culture. The situation, therefore, necessitates early adoption of improved method in rearing and breeding of these two exotic carps in the States. Besides, a technology of cultural practices is being developed by the CIFRI and this needs to be transmitted to the fish farmers. This will be possible only if there is a suitable farm in each State. The setting up in each State of a composite fish farm with an area of about 20 ha is of the utmost importance.

Fertilisers and Artificial Feeds

37.7.29 Besides increase in the stocking intensity of seedfish as an input for raising fish production from the available resources, the input aspects of using fertilisers and artificial feeds would need consideration. The prevalent practices comprise the use of organic manures mainly cow dung, and artificial feeds such as rice bran, oilseed cakes, etc. in nurseries and rearing tanks for raising fry and fingerlings respectively. But the introduction of these inputs in production units is hardly being undertaken.

37.7.30 Fertilisers: The use of fertilisers such as organic manures and chemical fertilisers is necessary to obtain desired levels of fish production on a continuous basis from ponds and tanks. But the motivation for the construction of most of the existing culturable resources has been mainly the need for water other than fish culture. The introduction of fertilisers in these resources will have, therefore, to be disciplined for the sake of maintaining the purity of water for drinking purposes, or its use for irrigation. The cultivation of short duration legumes in the exposed portions of ponds and tanks in the summer months, as already suggested in Paragraph 37.3.14 would assume considerable importance. The use of fertilisers would thus be possible only in those production units which are meant exclusively for fish culture or where the introduction of fertilisers would not be objectionable. In such units it would be necessary to determine the natural fertility of the ponds and tanks to find out the economic application of fertilisers of proper types, in required doses and frequencies.

37.7.31 The background knowledge developed so far, as a result of studies on the use of fertilisers mainly conducted at CIFRI, is not adequate for the formulation of rational fertiliser practices. It is, therefore, recommended that ICAR may intensify studies on the economic uses of different types of fertilisers and bring out extension literature on the same. It may also be necessary to devise a handy kit for undertaking analysis of water and soil. The State Fisheries Departments will have to organise the services of analysing soil and water of fish ponds and tanks and may consider the utilisation of services of the soil analysis and testing facilities organised by the State Agricultural Departments.

37.7.32 Artificial feeds: The use of artificial feeds in the intensive methods of fish culture has assumed importance all the world over for maximising per hectare yield. Artificial feeds have also been tried in our country in the experimental culture of composite carps. The growth rates of the major carps, which would form the important constituent of the carp culture in India, based on artificial feeds have, however, not been satisfactory. This would require intensification of studies on suitable supplementary or artificial feeds in relation to growth co-efficients of different species of carps in composite culture. This research would also be of equal importance in the culture of brackishwater fishes and prawns. Such supplementary or artificial feeds should be available in required quantities for large scale culture and their use should be economically feasible. This feed could be based on low cost raw materials. The possibilities of using different types of waste materials of which a wide variety are available in the country should be examined. The feeds produced should be in forms easy for storage and transportation and they should easily be accepted by the culturable fishes and prawns as direct feed. It is, therefore, recommended that the ICAR should step up research on artificial feeds from cheap or waste materials.

Potentiality of Increase in Carp Production

37.7.33 The culture experiments on composite carps that gave yields of about 8,000 kg/ha have been carried out in the farm ponds up to maximum size of 0.4 ha. The underlying consideration in making such an intensive fish culture an economical proposition would be to avoid the wastage of costly inputs such as manures, fertilisers and artificial feeds, owing to dispersal and dilution in larger bodies of water. To increase fish production from larger bodies of water on economic considerations the use of inputs will have to be limited to the increase in stocking density of seedfish for maximum utilisation of natural foods available in the ponds and tanks, supplementing their fertility by green manuring, and if necessary, by addition of fertilisers.

37.7.34 As has already been pointed out, the available freshwater culturable resources comprise nearly 1.5 million ha of which only 0.4 million ha may be in the units of up to about 10 ha each. The latter can be considered as smaller waterspreads suitable for intensive fish culture where the average yield could be raised from 750 kg/ha to 3,000-4,000 kg/ha. This order of increase in productivity would raise production from about 0.3 million tonnes to 1.2 = 1.6 million tonnes. From the remaining culturable resources of nearly 1.1 million ha made up of units above 10 ha, it should be possible to attain the average yield of nearly 500 kg/ha to produce about 0.55 million tonnes. Thus, the freshwater culturable resources available at present have a considerable potential for increasing carp production, and the attainment of about 2.0 million tonnes per annum should be considered as the target in the next 25 years.

Ponds Constructed for Intensive Carp Culture

37.7.35 The need for constructing small ponds as farming units exclusively for intensive fish culture has already been emphasised. The possibility of utilising suitable areas of freshwater swamps, particularly for reclamation into farming units for intensive culture, has also been indicated in the Section 4. In the general topography of land, there would be local depressions which may not be suitable for crop production due to high cost of their reclamation. Such depressions could be utilised for the construction of ponds if the natural replenishment from the rainwater and from the catchment area were adequate to maintain the desired level of water. In the command areas of irrigation projects water could be supplied from the irrigation canals to the ponds constructed on such otherwise unsuitable lands.

37.7.36 Economic considerations: Fish culture operations in the existing ponds and tanks have not so far, been subjected to economic evaluation and as such there are no reliable published reports on the subject. In the absence of such reports, it has been considered necessary to include here an examination of the economic aspects of fish culture to determine whether intensive fish culture in newly constructed ponds is profitable. This has been done on the basis that the credit available from the commercial banks would be on conditions at par with those in other sectors viz., at the interest rate of 10 per cent tenable in 1972-73. By taking a few case studies of fish production in the units of 0.4 ha the profits obtained could also indicate the magnitude of income for a fish farmer and his family taking up this occupation as a small scale venture.

37.7.37 The capital investment for providing a pond is the highest when such a unit is reclaimed from a suitable freshwater swampy resources. This amount for a pond of 0.4 ha would be around Rs. 5,000/-, which might be considered as capital investment. There would, however, be some suitable swampy areas, where the investment would be somewhat higher. On the other hand, in areas where only embankments and deepening would be required so as to undertake intensive fish culture, the expenditure would be of a lower order.

37.7.38 In the economics of fish production, the cheapest system would naturally be the one in which the entire growth of seedfish to marketable size i.e. the net fish production would take place at the expense of the natural foods formed in the ponds, involving no material expenditure for inputs except, of course, on the introduction of the seedfish. Practising this system is tenable in the case of the larger waterspreads but it would be wasteful in case of smaller waterspreads where higher yields could be obtained by putting to economic use the 'holding capacity' of water. Higher yields could be obtained, wherever possible, by making use of treated sewage and effluents from dairies, sugar factories, slaughter houses, breweries, starch mills etc. with a view to reducing the cost of inputs. It is also a common experience that ponds and tanks in the outskirts of towns and villages, receiving disposal of sewage or where herds of cattle cast their droppings, show considerably higher yields with no cost on inputs. But fish culture should take into consideration the use of inputs such as fertilisers, manures, and artificial feeds, on which the necessary expenditure has to be generally incurred. The case studies, given here, include costs on such inputs. Although the growth of fish is accomplished both through natural foods and inputs introduced, the total production has been taken into account in relation to the inputs, as it is difficult to account separately for the part of production due to natural foods alone.

37.7.39 Items of cost comprise the expenditure on inputs such as seedfish, manures, fertilisers and artificial feeds, netting cost including the depreciation charges on the gear and the labour involved in netting, cost of credit including interest and repayment of capital loan, and charges on account of repairs and maintenance of ponds. Cost also includes the charges on account of water supply, considered to be highest in the case of pumping out water from the central zone of *beels, mans* etc. to the marginal ponds. The return is in the form of amount realised from the sale of fish. The price obtained by the producer is the most important factor in the entire economic structure. In fact, this factor would constitute an index where intensive fish culture could profitably be undertaken. It is a common experience that the price paid by the consumers for the same type of fish varies considerably in different regions of the country. For example, the price of major carps in the eastern States would be much higher than in the other States. In considering the price which the producer should get in return, the cost of production and a reasonable consumer price in the country have been taken into account.

37.7.40 The economic estimates of carp culture, under three different sets of conditions, are given in the Appendix 37.3 viz.

(i) Major carp culture as is being practised in the country, with inputs comprising only the stocking of seedfish (vide column A of the Appendix). The production rate of 1,000 kg/ha, which is considered maximum, as intimated by the States, has been taken into consideration which, for 0.4 ha, would amount to 400 kg.

(ii) Major carp culture with inputs comprising increased stocking density of seedfish, manures and fertilisers, but no artificial feeds (vide column B of the Appendix). It is estimated that production of 3,000 kg/ha could be obtained under this system which for 0.4 ha, would amount to 1,200 kg.

(iii) Composite culture of major carps and exotic carps, with inouts comprising seedfish, manures, fertilisers and artificial feeds (vide column C of the Appendix). Against the production of about 8,000 kg/ha achieved in some of the experimental cultures, a conservative rate of 5,000 kg/ha has been taken into account which, for 0.4 ha, would amount to 2,000 kg.

37.7.41 The cost functions relating to inputs are based on the quantities used in the culture experiments and their respective 1972 prices. The cost of capital includes Rs. 500 as the yearly instalment of a loan of Rs. 5,000 on capital investment and Rs. 275 as average amount of yearly interest as also interest on the working capital which will vary under the three sets of conditions mentioned earlier. The cost of netting includes the depreciation amount of Rs. 100 on the gear costing Rs. 200 with a durability for 2 years and Rs. 100 as netting charges for 10 days on 4 labourers at the rate of Rs. 3 per day for 6 man-hours per day. The netting charges can, however, be saved if the small fish farmers organise themselves into groups for undertaking nettings in their ponds by turns. It may be clarified that the number of netting days taken is somewhat arbitrary. Now is it likely that the number of netting days would increase proportionately because of higher production in a pond. The miscellaneous expenditure includes the cost of repairs and maintenance of the pond. The expenses on the watch and ward have not been included, as it is envisaged that a fish farmer and his family staying nearby can undertake this work. The charges on account of water supply by pumping has been estimated to be Rs. 425 per 0.4 ha.

37.7.42 The cost of production of fish per kg under the three sets of conditions, A, B and C, comes to Rs. 3.37, Rs. 1.92 and Rs. 1.73 respectively. The price of major carps that the consumers were paying in West Bengal and neighbouring States in 1972 was around Rs. 8/- kg. and the price in other northern States around Rs. 6/- kg. Under these circumstances, the producer should have expected a reasonable price of Rs. 3/- kg. The return functions have, therfore, been estimated on this price of carp for the producer. The net receipts include the realisation after deducting all costs and the commission on sales at 5 per cent.

37.7.43 The main features of the cost-return balance sheet emerging from Appendix 37.3 are as below:

	A	B	C
fish production from 0·4 ha	400 kg	1,000 kg	2,000 kg
total cost	Rs. 1,775·00	Rs. 2,350·00	Rs. 3,200·00
cost of production per kg	Rs. 3·37	Rs. 1·92	Rs· 1·73
net receipts after deducting commission on sales	Rs. 1,140·00	Rs. 3,420·00	Rs. 5,700·00
profit or loss	(—)Rs. 635·00	Rs. 1,070·00	Rs. 2,500·00

It is seen that the present practice of major carp culture, as given in the column A shows a loss of Rs. 635 and as such it has no economic viability for utilising credit for the construction of new ponds. The same area with increased stocking intensity of seedfish and inputs comprising manures and fertilisers, as given in column B has indicated a profit of Rs. 1,070. The composite culture, under column C, with all the inputs including artificial feed, can yield a profit of Rs. 2,500. The culture of carps has to be limited to major carps alone or in combination with common carp till such time as the facilities are adequately developed for the production and distribution of seedfish of the other two species of exotic carps.

37.7.44 The above analysis of costs and returns indicate the economic feasibility of carp culture in the country. However, carp culture is a viable proposition only, if it is undertaken on an intensive basis with the use of appropriate packages of inputs. Intensive fish culture can be taken up in ponds reclaimed from suitable swampy areas with necessary loan and credit facilities from the commercial banks.

सत्यमेव जयते

37.7.45 Culture of common carp: In the efforts for maximising productivity, it has already been stated that artificial feeding of stock has a significant role. In this context, the common carp has, so far, been known to be the most amenable fish towards different types of artificial feeds with favourable index of growth co-efficient or food quotient expressed as:

$$\frac{\text{Weight of food given}}{\text{increase in weight of fish}}$$

This quotient for different feed items is as below[1]:

Food item	Food quotient
Fresh silkworm pupae	5·0-5·5
Dried silkworm pupae	1·3-2·1
Dehydrated blood	1·5-1·7
Fishmeal	1·5-3·0
Cotton-seed	2·3
Cottonseed cake	2·13-2·7

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[1] Bardach John E. *et al.* 1972. Aquaculture : 47 New York. Wiley Interscience.

Besides, this carp has other desirable characteristics such as the ease with which it can be bred under controlled conditions more than once a year giving necessary seedfish for multiple harvesting, wide range of tolerance to temperature and slight salinity conditions. It is because of these favourable characteristics that culture of the common carp has spread widely in both tropical and temperate countries and also in monoculture under different system that take advantage of larger bodies of water for intensive culture.

37.7.46 With artificial feeding of fish stock in embanked ponds, the *limiting factor in maximising production would* be the oxygen capacity of stagnant water. But, with water flowing into embanked ponds or in portions of streams or irrigation canals barricated with net-walls, production could be considerably increased. Under these conditions, a yield between 40-200 kg/sq. metre depending upon velocity of water, has been obtained in Japan and 8 kg/sq. metre in the Philippines. Considering that water has acquired the character of a much needed commodity, conditions would often not permit the construction of embanked ponds with flowing water arrangements. Use has, therefore, been made of larger bodies of freshwaters such as reservoirs and lakes, by supporting monoculture of common carp in floating net enclosures with a record yield of about 60 kg/sq. metre. In Indonesia, the culture of common carp in cages kept in polluted streams, without feeding has given a yield of 50-75 kg/sq. metre.

37.7.47 In India, the Indian major carps would, no doubt, continue to constitute the mainstay of culture in freshwaters, wherever possible. However, in operations depending solely on artificial feeding of stock, as in floating net enclosures, there would be a need to make large scale use of common carp, until such time as suitable artificial feeds for major carps have been found which can give yields comparable with those of common carp. The adoption of culture of common carp in floating net enclosures has a considerable potential in India in utilising larger bodies of water such as reservoirs and irrigation canals. It may also have a special significance in solving to some extent the problem of rehabilitation of people displaced as a result of impounding reservoir basins, after giving necessary training in this type of aquacultural operations.

37.7.48 Since the introduction of the Bangkok strain of common carp in 1957 and the much earlier introduction of mirror carp, these strains of common carp have been successfully established in almost all the States to produce increasing quantities of seedfish. There is still, however, a need for finding out the most economical types of floating enclosures and the requisite artificial feeds. It is, therefore, recommended that ICAR should undertake studies on the most economical type of floating net enclosures and artificial feeds for common carp with a view to adopting monocultural operations for undertaking intensive culture in larger bodies of waters for increasing production.

Culture of Air-breathing and Carnivorous Fishes

37.7.49 Precedence has to be given to the culture of carps, wherever possible, in confined freshwater resources. This is because these carps grow to a large size, have feeding habits close to the base of food chain, and also show favourable growth rates on artificial feeds which enables its low cost of production with good prospects of profitability. There would, however, be some freshwater resources, swampy areas, particularly where carp culture may not be feasible due to uneconomical reclamation costs, inadequacy of water or other conditions not conducive for carp culture. Such areas may, on the other hand, be congenial for the culture of air-breathing fishes, such as species of *Anabas, Clarias, Heteropneustes, Ophiocephalus* etc. Being carnivorous, with some of them even preying on their own young ones, the recurring stocking of seedfish in ponds and tanks which cannot be completely cleared of these adult fishes would pose hazards both in polyculture with other fishes or in their own exclusive culture. Their harvesting has also been found difficult because of their habit of lying at the bottom and getting into the mud. As such, culture of air breathing fishes is to be preferred in cages. The techniques of cage culture are being standardised by the ICAR under the Coordinated Research Project on the subject. Efforts are being made to fabricate the cages economically from the locally available materials. Possibilities of seedfish production by induced breeding, supply of artificial feeds etc. are also being investigated. Till the production of such air-breathing fishes is based on supplies of artificial feeds, their culture could only be a part-time occupation for earning supplementary income. Like the large scale catfish culture industry in the USA, which is mainly dependent on the supply of artificial feeds, there would be a possibility in India for considerable expansion of culture of air-breathing fishes.

Trout Culture

37.7.50 The modernisation of hatchery practices and the use of dry feeds to get the maximum survival of seedfish of trout for artificial 'propagation in the coldwater streams has already been dealt with in Paragraph 37.2.13. The most economical dry feeds for culturing trout as table fish has yet to be found out. The transformation of trout culture operation from merely catering to requirements as sport fishery to commercial production in constructed ponds and narrow raceways, supplied with adequate quantity of flowing spring or surface coldwater of requisite temperature amenable to trouts has become a good possibility. The yield of 15 kg/sq. metre attained in the USA is a good example of the potential of trout culture under optimum conditions. Commercial trout culture is possible in those areas where there is *spring or surface* cold water along with a suitable terrain, soil and space for the construction of ponds or raceways. There may, however, be areas where even with the requisite water supply available, other conditions may not be suitable for the construction of ponds. In such circumstances fibreglass containers have been experimentally tried and in one experiment a production of 2,700 kg in a container of 20,000 litre capacity has been attained.

Mahseer Culture

37.7.51 Mahseer stocked in confined waters in hilly areas as well as the plains have been known to fare well. The recent success in their artificial breeding and in rearing the fry under controlled conditions has indicated the possibility of seedfish production of mahseer for undertaking cultural operations. In comparison to the trout which requires sophisticated arrangements for seedfish production, the conditions required for mahseer are much simpler with a considerably shorter incubation period and greater chances of securing better survival of seedfish. Detailed studies on food and feeding habits of the different species of mahseer are required to be undertaken so as to find out the necessary artificial feeds and conditions of culture under different temperatures. Success in mahseer culture in hills and plains has a great potential in providing sport fishing in tourist resorts. Besides, the eggs of mahseer are of a size comparable to caviar which is a world renowned gourmet food and the possibility of utilising mahseer eggs for caviar, could also be examined.

Hilsa Culture

37.7.52 Attempts prior to 1907, had led to a partial success in artificially fertilising the eggs and rearing Hilsa up to fry stage with the objective of re-stocking the rivers where the *Hilsa* fishery was affected by the construction of barriers in its migratory run. It was only after the revival of these investigations after 1968, that success was achieved in rearing *Hilsa* in freshwaters not only upto the fingerling stage but even upto about 20 cm size which was attained in about 9 months. Further studies on improving the survival rates of fry and fingerling raised by artificial fertilisation and finding out the best feeds for the different stages upto the size of table fish would eventually make *Hilsa* culture a possibility.

37.7.53 Success of *Hilsa* culture would make it possible to transplant this species in the coastal streams of the west and east coasts of India. Such a transplantation has a parallel in the examples of the Atlantic salmon and the Pacific salmon. The fishery of these salmon, which are also anadromous fish ascending freshwater streams for breeding, is exploited in the estuaries and in the rivers. The natural sea fisheries of the salmon were found to undergo depletion due to considerable increase in their fishing intensity and introduction of high sea fishing for them, and also due to other factors such as deterioration of the natural spawning streams by the water pollution construction of dams and barrages and the rapid rate of urbanisation. To compensate for this, the natural sea fisheries are being enriched not only by large scale stocking of the young ones of salmon reared in the hatcheries, but also by establishing new spawning streams. The latter should serve as an encouraging precedent for trials on establishing new spawning streams for *Hilsa* in India.

8 CULTURE IN BRACKISHWATERS

37.8.1 Brackishwater fish culture is practised by traditional methods, and is an old industry in India. It is mainly undertaken in the *bheris* in the Sundarbans area of West Bengal and in the paddy fields along the margins of backwaters in Kerala. The practices in both these regions, although differing in details, follow the same basic principle, namely, 'trapping-cum-holding'. Fish and crustaceans in their young stages which enter the fields with the on-coming tide are trapped and grown for some months, until they attain a marketable size or are harvested wholesale before the next monsoon. This activity in the other coastal areas is negligible. In contrast to the brackishwater fish culture, based on the principle of selective stocking, as practised in other countries of the Indo-pacific region, such as Indonesia, Philippines, Thailand and Taiwan, the industry in India has not made any progress, despite the potential for it by way of brackishwater resources available in the country. According to Indonesian tradition, the brackishwater culture in that country which is so well developed was originally introduced from India during the medieval times.

37.8.2 The area at present under brackishwater culture in India is estimated to be about 12,000 hectares. The total extent of coastal saline swamps is about 1.42 Mha.

distributed in the respective maritime States[1] as follows:

State	Brackishwater area (Mha)
Gujarat	0·376
Maharashtra	0·080
Karnataka	0·080
Kerala	0·200
Tamil Nadu	0·080
Orissa	0.008
Andhra Pradesh	0·200
West Bengal	0·400
total	1·424 or 1·42 Mha

The actual area suitable for construction of ponds for culture would, however, be subject to several limiting factors of physiography. No survey has so far been undertaken to map out suitable areas for brackishwater fish farming. It is, therefore, suggested that the survey of brackishwater resources in the maritime States should be undertaken as expeditiously as possible with a view to mapping out suitable areas for fish culture. The ICAR should develop the methodology to be adopted for undertaking the survey, including the field studies. If necessary, the staff of the State Fisheries Departments should be trained to undertake the survey work.

37.8.3 In the present system, which is merely 'trapping-cum-holding' the composition of seedfish and prawns is necessarily of the mixed type, containing both desirable and undesirable forms. Brackishwater culture, as is being practised in other countries, involves selective stocking, mainly with the seed of milkfish--*Chanos-chanos* (Forsk.), mullets (*Mugil* spp.) and some selected species of prawns either as monoculture or polyculture. Another noncarnivorous fish, suitable for brackishwater culture and preferred in some parts of India particularly Kerala, is the pearl-spot, *Etroplus suratensis* (Bl).

Milkfish Culture

37.8.4 Although an inhabitant of the sea, the milkfish does not constitute a marine fishery of any significance, because of difficulties in fishing for this species. They spawn in the sea near the coast and the larvae move into clear coastal creeks and estuarine waters, occasionally ascending further up. After about a year or so of inshore life the young ones, about 20 cm in length move out to the sea. Large quantities of seedfish are available in certain coastal and estuarine areas and this makes it possible to undertake large scale culture of milkfish. This fish is highly resistant to salinity changes and is, besides, a good quality food which grows rapidly on algae and other vegetation.

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[1] 1968 (January) Indian Fisheries Bulletin Statistical Number : 6.

37.8.5 Large scale culture of milkfish is being practised in Indonesia (150,000 ha), where the trade in the seedfish is well organised. In recent years, the old method of taking only one crop a year, has been replaced by a system of multiple cropping (3 to 4 crops a year) by repeated stocking and harvesting and by using inputs such as organic manures, chemical fertilisers and supplemental feeds, comprising rice bran, peanut cake, soyabean cake etc. wherever necessary. Multiple cropping is possible because of the long and protracted season of seedfish availability and deliberate action on the part of seedfish suppliers to retard the growth of fry and fingerlings for supply of seedfish more or less throughout the year.

37.8.6 In India the natural distribution of milkfish which would also be the range of seedfish occurrence, is to the south of Chilka lake on the eastern sea board, and to the south of Goa on the west coast. Collection of seedfish is undertaken along the coast of Andhra Pradesh. Tamil Nadu and Kerala where milkfish culture is practised on a very small scale. In addition to being euryhaline, the fish has been found to be hypersaline, thriving and yielding well in saline lagoons and salt pans, a fact which has been established by the Central Marine Fisheries Research Institute (CMFRI).

37.8.7 At present only a small portion of the total quantity of seedfish available is collected for milkfish culture. There is, therefore, need to organise large scale collection of seed of milkfish after thoroughly prospecting all possible localities. This natural resource will be the only available source as the possibilities of producing seedfish by pituitary hormone injection are remote since milkfish does not mature in brackishwater.

Mullet Culture

37.8.8 Mullet culture has gained importance in several parts of the world, because these fishes are considered high quality fish. The mullets are also highly priced in India. Despite their importance and the scope for their culture by way of availability of seedfish, these resources have been little utilised.

37.8.9 The occurrence in fairly large quantities of fry of different species of mullets has been recorded from both the east and west coasts of India, with particular abundance from Hooghly-Matlah *estuarine* system, Mahanadi estuarine system, Chilka Lake, Pulicat Lake, Palk Bay and the backwaters of Kerala. There is, however, need to undertake organised and systematic prospecting of seedfish of mullet from natural resources. Besides, there are possibilities of breeding these fishes by pituitary hormone injections, as mullets are known to mature in brackishwaters. Some experimental success has been reported, but techniques have still to be perfected.

37.8.10 Experiments have been conducted by the CIFRI on the mullet culture, indicating a production rate of 2,400 kg/ha in 210 days, by using rice bran and mustard oil cake as supplemental feed. These experiments have shown that there is considerable scope for brackishwater fish culture by selective stocking with mullets. Data regarding the performance of individual species are lacking as they are often raised in mixed cultures. In the intensification of fisheries of Pulicat and Chilka Lakes, mullets have to play an important role and it is quite likely that some of these species may prove to be of value in the little Rann of Kutch.

Pearl Spot Culture

37.8.11 The culture of pearl spot would be of considerable significance in some parts of South India, particularly in Kerala and Goa where it constitutes one of the most highly priced fish. It is caught in very small quantities, alongwith other estuarine fishes. It is also cultured on a small scale in brackishwater impoundments. The pearl spot breeds almost throughout the year. In the estuaries it lays eggs on the underside of submerged objects. Some of the culturists take advantage of this character by providing slabs of stone or slate in their ponds. It can easily be made to spawn under conditions of captivity. This fish has the desirable characteristic of feeding mainly on algae and decaying plants.

37.8.12 With the prospects of seedfish availability throughout the year, seedfish production under controlled conditions, and its favourable feeding habit, it is considered that pearl spot culture can expand considerably in the States where its supply falls far short of demand. It may also be possible to take more than one crop a year but this needs investigations on the requisite inputs for accelerating its growth.

Economic Considerations

37.8.13 The economic of culture in brackishwaters as indicated by mullet culture are given in Appendix 37.4. It has been stated that under experimental conditions, the yield of 2,400 kg/ha has been obtained in 210 days, which works out to be about 4,150 kg/ha in a year. Similar records of mullet production under intensive culture, have also been attained in Taiwan and Hong Kong. Selected stocking with suitable species—combination of mullets, (such as those feeding at bottom, or on plankton and filamentous algae) and introduction of inputs such as fertilisers, manures, and artificial feeds, can give a yield of about 3,000 kg/ha per annum. There are also possibilities of increasing the production further in mullet ponds by combining mullet culture with that of carp in such salinities that are within their thriving range. For estimating the economics, the conservative rate of 3,000 kg/ha has been taken into account which, in 0.4 ha, would be 1,200 kg. The scale of costs, excepting those on inputs, are similar to those carp culture. Mullets being equally highly-priced fish like carps, not only in the eastern sector but also in the coastal regions, the price to the producer taken into account is Rs. 3 per kg. After meeting the total cost of Rs. 2,250 per annum and the commission on sales, there is a profit of Rs. 1,170/- per unit of 0.4 ha which indicate that the brackishwater culture with selective stocking can also be economically viable.

37.8.14 Additional income from coconut cultivation: Cultivation of coconuts can form a useful and lucrative adjunct to brackishwater fish farming. Coconut palms, being hemihalophytes can tolerate saline environments. Raising these palms on embankments is already a well established practice in many of the low-lying areas in the coastal regions. Besides the additional income from coconut plantations, the fish farmer-cum-cultivator is benefitted indirectly as the roots strengthen the embankments through their binding effects.

37.8.15 The economic of cultivating one coconut palm of ordinary tall variety is given at Appendix 37.5. The analysis is based on the information furnished by the Directorate of Horticulture of the Ministry of Agriculture & Irrigation and the Central Plantation Crop Research Institute at Kasaragod and takes into consideration the costs and returns and rate of interest at 10% as tenable in 1972. The cost includes expenditure on hired labour for making pits in the first year but does not include labour charges for maintaining the cultivation from second year onwards, as it is envisaged that the fish farmer and his family should be able to do this work.

37.8.16 The life of ordinary tall variety of a coconut palm is considered to be 60 years. The palm does not bear nuts during the first 5 years. In the next five years each palm yields 5, 20, 30, 40 and 50 nuts in successive years. The full fruition of 75 nuts per palm commences in the 11th year. The harvesting charges of nuts are taken at Re. 1/- for 50 nuts. The realisation from the sale of nuts is estimated at Rs. 50 per 100 nuts. The cost of cultivation would be approximately Rs. 16, Rs. 4 and Rs. 4.75 respectively in the first three years, followed by Rs. 6.25 per annum from the 4th year onwards. As there are non-fruition and partial fruition phases of 5 years each, there would be additional liability of accumulating credit and interest charges on it. The accrued liability before repayment commence would be of the order of Rs. 71.25. The farmer would be in a position to meet the maintenance cost of cultivation of Rs. 6.25 from the sale realisation only after the end of the seventh year. The amounts of loan repayments are calculated after deducting from the sale realisation the cost of cultivation and his household expenditure upto a maximum of Rs. 5/- during the period of credit liability as an incentive to sustain his interest in cultivation. From the 14th year onwards the farmer would get a net annual income of Rs. 29.75 so long it yields 75 nuts.

37.8.17 In the perimeter of 280 metres around a pond of 0.4 ha (100 metres × 40 metres) approximately 46 palms could be planted on the embankments at a distance of 6 methods apart. The income from 46 palms has been shown in col. 11 of Appendix 37.5. During the 6th to 13th years, the income would be between Rs. 115—230 per annum. After the completion of the period of liability i.e. from the 14th year onwards, the farmer will have an income of about Rs. 1,300/-.

37.8.18 As the coconut cultivation involves a gestation period the farmer would require working capital for 7 years, without any capacity to make any repayment during this period. However, he would be able to discharge his liability of repaying entire credit along-with interest during the 8th to 14th years of planting. It is, therefore, considered that coconut cultivation on embankments of brackishwater ponds for additional income would need long term credit of nearly 7 years duration and long term repayments extending upto 14 years.

General Considerations

37.8.19 The development in brackishwater culture will primarily depend upon the availability of seed of desired species from natural resources. Although the potentiality of some resources has been indicated by the investigations undertaken so far, there is a need for further detailed studies. It is, therefore, recommended that urgent attention should be given to the prospecting of all available natural resources in the country for seed of brackishwater fish and prawns of desired species. Investigations should also include nursery management practices and economic methods of transport and distribution with a view to eventually organising the brackishwater fish and prawn seed industry. In the case of mullets and prawns, it will be necessary sooner or later to supplement the production of seed by breeding them under captivity.

37.8.20 The results of experimental culture of mullets and prawns at the Experimental Fish Farm of ICAR at Kakdwip (West Bengal) have been fairly encouraging. Survey and investigations on the seed resources conducted in the Sundarbans have indicated the prospects of undertaking scientific brackishwater culture in the region. The brackishwater systems are, however, spread all along the Indian coast, and each system has its own specificity of environmental and biological factors. It would, therefore, be necessary to study each system separately, as a pre-investment study by establishing experimental fish farms at strategic centres. These farms should serve as units with a common package approach to all aspects including that of demonstrating economic viability to generate the necessary ethusiasm amongst the weaker sections of the community living in the areas adjoining the coast and brackishwaters. It is, therefore, recommended that the research agencies of the Centre (ICAR) and of the concerned States (Fisheries Departments and/or Agricultural Universities) should undertake pre-investment studies in a coordinated manner, by establishing brackishwater experimental fish farms at suitable centres. Since the vast extent of brackishwater resources have so far remained under-utilised, it is considered, that these studies should be undertaken as expeditiously as possible with a view to capitalise the potential of brackishwater areas by starting intensive work at the experimental farms and the dissemination of the field practices to surrounding areas.

9 MARICULTURE

सत्यमेव जयते

37.9.1 This Section deals with marine forms which are being cultured on a commercial scale in other countries. It also deals with the present status of culture of the corresponding forms and the developmental possibilities in our country. Commercial culture of molluses such as edible oysters and mussels is an age-old practice in Japan and some of the European countries. The culture of these shellfish later on extended to other maritime countries wherever demand for these exceeded the quantities caught from the natural beds. Until recently the farming operations had not progressed beyond traditional practices. Advances in scientific knowledge of the biology of these shellfish led to refinements in the techniques of culture of both seed of shellfish or spat and adult oysters and mussels.

37.9.2 Commercial mariculture has not extended to other marine forms except in Japan where all possible and promising locations comprising mainly fertile bays, lagoons, inter-tidal zones and inshore seas, are being utilised for the culture of molluscan shellfish, fish and algae for food, as well as for the culture pearl industry.

Culture of Edible Oysters

37.9.3 Amongst several species of edible oysters recorded from the Indian seas, only four species are known to occur in appreciable quantities with a definite pattern of distribution. *Crassostrea gryphoides* (Schl.) and *C. discoides* (Gould) are the two important species, inhabiting the creeks along the west coast in the States of Gujarat, Maharashtra and Karnataka. *C. Madrassensia* (Preston) is a predominant form in the estuaries and backwaters of Kerala, Tamil Nadu and Andhra Pradesh States, and the fourth species *C. cucullata* (Born) has a habitation mostly on the rocky substratum on both east and west costs. Although oysters are known to be highly nutritious, rich in gylcogen, proteins and vitamins, their consumption in our country is very much limited even amongst the coastal population. Except for a very limited oyster culture, involving collection of young oysters and transplanting them on suitable grounds near Bombay and Madras to meet the demand of western style hotels, no need has been felt in the country to undertake production beyond the quantities collected from the natural beds. The potentialities for oyster culture would, however, need consideration from the viewpoints of export of this commodity in canned or deep frozen form and increased consumption within the country which could follow mass promotional efforts.

37.9.4 Oysters are cultured on a commercial scale to meet the high demand in several countries such as the USA, Canada, Holland, France, Japan, Philippines and Australia. The technology of oyster culture basically involves the placement of suitable objects for the settlement of spat or seed-oysters and growing the spat to adult oysters in the most productive areas. The old method of oyster culture, commonly known as bottom-culture, comprises providing spat collectors or objects for settlement of spat and growing them to adult oysters at the bottom. As bottom culture of oysters was subject to considerable hazards of predation and siltation and required laborious transplantation several times in the 2-4 year period of culture, improved techniques of off-bottom culture are being increasingly adopted. This involves use of suitable objects as spat-collectors and growing adult oysters on objects suspended either from floating rafts or long lines. The comparative yields from the bottom-culture and off-bottom culture is given in Table 37.2[1].

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[1] Bardach John E *et al.* 1972—Aquaculture: 735. New York. Whily Interscience.

TABLE 37.2

Average Yield in Bottom and Off-bottom Modes of Culture of Oysters in Defferent Countries

Country	Species	Culturing method	Production (meat weight, shells excluded) (kg/ha/year)
1. France	*Ostrea edulis*	bottom culture	250
France	*Crassostrea angulate*	,,	1,000
2. Japan	*Crassostrea gigas*	off-bottom culture-long lines	26,000
Japan (North)	,,	off-bottom culture-raft	1,000
Japan (South)	,,	,,	20,000
3. USA	*Crassostrea virginica*	bottom culture with intensive management	5,000
USA		bottom-culture with little or no management	10—1,000

It can be seen from the above table that off-bottom culture yields much higher production than the bottom culture. It also shows that off-bottom culture in productive areas as in south Japan yields much higher production than in non-fertile areas as in North-Japan. The continuance of bottom culture in some of the countries like the USA, Canada and France, is mainly due to legal obstacles in leasing out the necessary areas, whereas in Japan, the prefectural governments allocate space for oyster culture to the local fishermen's cooperative associations which, in turn, grant the use of specific areas to the individual farmers. The culturists do not pay for using these areas except indirectly through the cost of membership in the cooperative associations. It has, however, been reported that expansion of oyster culture in some of these countries either by bottom or off-bottom culture is affected adversely by domestic and industrial pollution in the coastal areas and the development of coastal areas for purposes other than mariculture. Pollution constitutes a serious threat to molluscan shellfish industry. Not only that the animals are directly affected in polluted areas, but even in the areas where they may not be directly harmed, the oysters, because of their peculiar filter feeding habits, can concentrate pollutants in their flesh and become unift for consumption. The virtual stoppage of oyster production in New York which was the principal oyster producing State in the USA is an example of the catastrophic effects of pollution on oyster beds.

37.9.5 Considering that the expansion of oyster culture is threatened by heavy pollution effects in coastal areas and estuaries in oyster consuming countries and that there is a potential for increase in demand in these countries, the possibilities of large scale culture and export of Indian edible oysters could be explored. It would be necessary to develop the requisite expertise in advanced techniques of oyster culture. We, therefore, recommend that the ICAR should undertake investigations on different methods of oyster culture with a view to finding out suitable and economical techniques to be adopted. The maritime States should undertake surveys for finding out productive areas for spatfall and for growing adult oysters.

Mussel Culture

37.9.6 Edible sea-mussels are represented in our waters by the green mussel, *Mytillus viridis I* and the brown mussel, *Mytilus sp.* The green mussel has a wider distribution, occurring all along the east and west coasts, whereas the brown mussel has greater abundance along the southern coastal region of Kerala. Mussels attach themselves by their thread like processes called byssus to rocks and structures such as piers, wharves etc. Being highly gregarious in behaviour, they are found in large concentrations wherever they occur. Fishing for mussels is mainly undertaken in Kerala and some parts of Karnataka and Maharashtra where it is mainly consumed by the people of the coastal areas. Their highly nutritious value has not been realised in India, and as such, it has not been felt necessary to increase production by culture techniques, although mussel culture could be one of the most productive forms of mariculture.

37.9.7 Mussels are not as popular as oysters in other countries. Their demand as an export commodity would, therefore, be more limited. The main consuming country is France, which imports large quantities from other European countries. The other consuming countries are Netherlands, Spain, Belgium, Italy and UK. The techniques, adopted for mussel culture in European countries are very similar to those of oyster culture. In Spain, raft culture has been reported to yield about 600,000 kg/ha of mussels with shells, which would be nearly 300,000 kg. of mussel-meat.

37.9.8 The mussel culture, with the application of advanced techniques, could be one of the most productive forms of mariculture. Rope culture for mussels has been successfully developed in Tuticorin and Vizhinjam and has great prospects for expansion. It would be advantageous to establish the economic feasibility of mussel culture with a view to utilising suitable coastal areas for increased production of mussels for export as well as for domestic consumption through education in their acceptability. Economics of alternative use of mussels for making mussel-meal like fish meal for use as livestock feed may also be examined.

Clam Culture

37.9.9 The edible clams, mainly represented by *Meretrix meretrix* (L.), *M. casta* (Chem.), *Katelysia opima* (Gmelin), *Villorita cyprinoides* (Gray), *Gafrarium tumidum* (Roding) and *Paphia* spp., are found in greater abundance than oysters and mussels on both the coasts of India, in backwaters, estuaries and inter-tidal regions. They are better utilised than oysters and mussels, and are mostly eaten by the poorer people in the coastal regions. As clams do not attach themselves like oysters and mussels, they are easy to harvest by hand-picking. This is mostly done by the poorer fishermen and their families, who have no means of undertaking fishing by craft. It has, however, been reported that due to prevailing indiscriminate fishing for edible claims at several places, the natural beds have become depleted. Besides, the clam beds are being affected by the discharge of the polutants into rivers, estuaries and coastal regions and deposition of silt on account of floods in rivers. In the interest of proper management of the clam fishery resources of the country, it would be necessary to undertake resources survey of the areas of availability, compile statistics of catches and replenishment by natural recruitment etc. It would also be necessary to adopt proper culture techniques for increasing production.

37.9.10 Clam culture is mainly carried on in Japan and the USA. As clams are not amenable to off-bottom culture, the culture techniques are much simpler than in the case of oysters and mussels. These involve mainly the transplantation of clam seeds from densely populated beds where extensive spawning occurs to under-populated beds where they would grow much faster. Transplantation of clam seeds is also undertaken in new areas having suitable bottom, neither soft nor hard, for creating new clam beds. In the USA where clams are considered as a luxury, the seed clams are produced in hatcheries by spawning clams throughout the year. In India, similar attempts can also be made to culture clams by transplantation in suitable areas.

Culture Pearl Industry

37.9.11 Formation of natural pearls takes place inside some of the molluscan animals such as the pearl oysters, window-pane oysters, freshwater mussels, top-shells, turban-shells etc. It involves biological process of accumulation of pearly or nacre secretion, as a defence against an irritant particle or 'nucleus', which may accidentally enter the animal's body cavity where it gets stuck up in the membrane or mantle. The pearls formed in the pearl oysters belonging to the genus *Pinctada* are considered to be of excellent quality and lustre. Of the six species of *Pinctada* known from the Indian coast, *P.* fucata (Gould) is commercially important as the source of oriental pearls of great renown. The beds of this pearl oyster are found in the Gulf of Mannar off Tamil Nadu and the Gulf of Kutch off Gujarat; the beds are more extensive in the former region than in the latter.

37.9.12 For the extraction of natural pearls, the pearl oyster fishery was operated by the respective State Governments. It has been reported that the quantities of pearls obtained were not always appreciable due to unproductive years intervening between successful fisheries. The pearl oyster fishery of the Gulf of Mannar had been operated only 27 times during the period between 1796 and 1961, and since 1962 no fishing has been organised. In the Gulf of Kutch, from 1926-27 to 1966-67, there have been 17 operations and since 1967-68 no fishery has been operated. Investigations undertaken, including the underwater survey of pearl oyster beds with the help of aqualung diving by the scientists of the CMFRI, have indicated depletion in the population of pearl oysters, mainly due to predation and siltation and the overfishing of beds in the years 1958-62. Attempts have also been made to propagate the pearl oysters, but these did not yield any appreciable results.

37.9.13 The industry based only on the extraction of natural pearls, wherever pearl oysters occurred in the world, was very low in productivity. This was mainly due to the fact that in nature the entry of nuclei into the oysters was only accidental which gave very low percentage of incidence of pearl formation. This necessitated the opening of all pearl oysters to find out which contained pearls; the pearls yielded were of different shapes due to different kinds of original nuclei and of these only spherical pearls had ornamental value.

37.9.14 The low productivity of natural pearls gave rise to the development of the culture pearl industry. The formation of culture pearls involves the same biological process as in the case of natural pearls. The only difference in case of a culture pearl is that a spherical nucleus originating from suitable mollusean shell, is introduced along with a piece of mantle and grafted on to the body of the pearl oyster in the first instance. The rest of the process of secretion around the nucleus to form a pearl is the same as in the natural pearl. Both the introduction of nuclei and grafting of mantle pieces involve skilful operation.

37.9.15 The technology of pearl culture was evolved in Japan where the spherical pearls were produced for the first time in 1907 by Mikimoto. Until it entered into collaboration with Australia, Hong Kong and Burma, Japan had a monopoly in the technology, production and marketing of culture pearls in the world for nearly five decades. The progress in the development of culture pearl industry in Japan, during the period 1958-68, as indicated by the number of rafts in operation and the yield of spherical pearls of large, medium and small sizes, can be seen in the Table 37.3[1].

TABLE 37·3

Culture Pearl Industry in Japan during 1958—68

Year	No. of rafts	Yield of spherical pearls (kg) Large size (over 8 mm)	Medium size (8-6mm)	Small size (less than 6mm)	Total
1958	114,965	5,204	16,466	26,413	48,088
1959	97,642	6,704	20,688	23,916	51,303
1960	102,575	13,482	26,376	20,549	60,407
1961	111,678	17,768	31,468	23,740	72,976
1962	137,893	18,652	33,507	26,891	79,050
1963	158,665	17,686	33,932	36,760	88,378
1964	193,462	17,334	38,355	32,897	88,589
1965	225,505	19,090	46,816	48,156	114,062
1966	253,624	24,670	65,120	40,506	130,296
1967	257,139	24,224	63,136	39,053	126,413
1968	242,987	17,575	51,332	35,279	104,186

It can be seen from the table that the production of culture pearls in Japan had reached the maximum in 1966, after which there has been a setback in the industry. The causes of decline were

(i) the increased pollution effects in the areas where pearl oysters are being farmed,

(ii) insufficient supply of labour, and

(iii) increased wages.

Japan imports shells of species of *Pleurobema* and *Megalonias* from the USA from which the spherical nuclei are made. There has been a reported shortage of these shells. The culture pearl industry has virtually come to the break-even point as can be seen from the cost and returns in the industry in 1969 given below:

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[1] Furukawa A., 1972. Present Status of Japanese Marine Aquaculture in Coastal Aquaculture in the Indo Pacific Region : 41. London. Fishing News (Books) Ltd. FAO.

Item	Dollars($)
no. of sample units : 14	
gross earnings	11,003
expenses	11,007
wages paid	1,130
estimated wages of family labour	1,968
boat maintenance	139
fuel and oil	107
miscellaneous materials	137
fishing equipments	154
marketing	110
other charges and fees	1,461
office expenses	128
depreciation	2,484
net income	—4

37.9.16 With the main objective of developing the indigenous technology of culture pearls and raft-culture of pearl oysters, the CMFRI undertook experiments in 1973 at Veppalodai near Tuticorin in Tamil Nadu using imported as well as indigenously produced shell-beads as nuclei. The first culture pearl was produced on July 25, 1973 and confidence in the reliability of technology was gained when more culture pearls were collected from the oysters in which the nuclei were implanted. The rate of growth of culture pearls was found to be faster in our waters than in the temperate waters of Japan. The successful maintenance of the pearl oysters at Veppalodai in turbid waters at a shallow-depth of 4 metres has indicated the possibility of pearl oyster farming in several places along the coast, as against the pearl-oyster farming in Japan and Australia where it is confined to calm bays amongst groups of islands.

37.9.17 This initial success in developing indigenous technology of culture pearls should encourage further intensified research. This would comprise detailed studies on the biology of pearl oysters, production areas of spat fall and for farming pearl oysters, controlled breeding of pearl oysters and production of spat under captivity conditions, refinements in raft culture and culture pearl technology and large scale production of shell-beads as nuclei from indigenously available shells. Further, the study of the economic feasibility of culture pearl industry through a pilot project is required for its development in our country. Some of the countries producing culture pearls are confronted with adverse problems in expanding their culture pearl industry and this provides India an opportunity to make a thrust in this field.

Culture of Marine Fish

37.9.18 The culture of fish in seawater is not being practised in India. In other countries also culture practices have been carried out with objective of, either augmenting the natural stocks in the sea by liberating the young reared under captivity as in the case of salmon, flatfishes, cod etc., or culturing fish to marketable size from the seedfish produced under captivity conditions or collected from the sea. Except for salmon, most of the cultural practices with reference to the rearing of young for purposes of merely supplementing the natural stocks have been discontinued as these were considered to be uneconomical and their productivity doubtful. The culture of marine fish to marketable size can be stated, in general, to be more under experimental stage than having, attained levels of commercial importance. There is, however, one outstanding example of a large scale commercial culture of marine fish, which is described here to illustrate the future possibilities of the culture of marine fishes in India.

37.9.19 The strong demand for Yellowtail, *Seriola quinqueradiata*, in Japan, stimulated the cultural practices for this fish to supplement quantities caught from the sea. It has been reported that the catch of yellowtail in 1970 was about 55,000 tonnes and the production of farmed yellowtail was nearly 51,000 tonnes cultured in embanked ponds, net enclosed areas of the sea and floating not cages. Of these three types of cultural practices, the floating net cages have proved to be most efficient and as such this method is now fast spreading throughout the country.

37.9.20 The seedfish in the form of fry are caught from the sea as this fish has not been bred in captivity. With a view to putting a ceiling on seed fish collection from wild stocks, licences are isued for the collection of seedfish. The seedfish are then graded according to size into small, medium and large categories as otherwise mixture of different sizes would result in cannibalism. As the fish are carnivorous, the feed given mainly comprises minced fish, mainly sand-eel and anchovies. No artificial feed has been found to be useful. The yield of nearly 200 tonnes per ha has been reported from some of the well-managed units, which carry out multiple cropping system similar to that of milkfish culture.

37.9.21 The example of yellowtail fish culture has thus indicated that there might be possibilities of intensive culture of prime varieties of marine fish, particularly in net cage enclosures, provided such fishes could be breed under captivity conditions or adequate quantities of seedfish could be collected from wildstock without affecting the natural fisheries and suitable feeds could be found so as to make the culture economically feasible. In this context, the mariculture of two important species of threadfine or Polynemids, *Polynemus indicus* (*dara*), *Eleutheronema tetradactylus* (*rawas*) and one of the sand-whitings *Sillago sihama,* which are highly priced fish, would need consideration because of their depletion in the quantities landed.

Culture of Marine Algae

37.9.22 Marine algae or seaweeds are commercially important, directly as human food or as livestock feed and fertilisers, and indirectly as raw material for industry. Some of the red and brown algae are used for the manufacture of agar-agar and derivatives of aliginic acid which are used in food, cosmetics, pharmaceutical, textile, leather and several other industries. Amongst the countries consuming marine algae as human food such as Japan, Korea, China and some of the other East Asian countries, the culture techniques have been considerably developed in Japan. It has been reported that almost the entire quantity of the most favoured type of marine algae, *Porphyra* or 'nori' as it is locally called in Japan, is being produced by culture methods. This culture yields a profit of 50 per cent on the investment.

37.9.23 Chemical industries based on marine algae as raw material have been well established mainly in the USA, UK, France, Norway and Japan. Most of these industries depend on the raw material collected from the sea as well as on imports of the dried algae from other countries. India also exported dried marine algae to the extent of about 300 tonnes per annum during the period between 1962 and 1967. The worldwide expansion in the industries requiring agar-agar and derivatives of alginic acids would inevitably encourage considerable increase in the production of raw material by culture methods as the collection from the natural beds would not be sufficient. Production by culture methods would assume greater importance in tropical countries like India as the natural growth is not as luxuriant in the tropics as in the temperate regions.

37.9.24 In India, seaweeds are available in considerable quantities only in certain localities such as the Gulf of Mannar, Gulf of Kuch, Chilka Lake and around the Andamans and Nicobar, Lukshadweep and other islands. They also occur in smaller quantities at several places along the entire sea-board of India. The developments in commercial utilisation of marine algae as raw material started only subsequent to the Second World War. By 1960, there were about six industrial units utilising marine algae and manufacturing about 175 tonnes of agar-agar and 75 tonnes of sodium alginate. The seaweeds which are used in the industrial units chiefly come from the Gulf of Mannar. It has, however, been reported that the supply of raw material, particularly the marine algae yielding agar-agar, is hardly sufficient to maintain one-third of the production capacity of the industrial units so far started. This would, therefore, point out the necessity for increased production of marine algae not only for the units already established but for those to be established in the next 25 years. The survey of the seaweed resources of Gulf of Mannar has been undertaken jointly by the Central Salt and Marine Chemicals Research Institute of the Council of Scientific and Industrial Research, CMFRI and State Fisheries Department of Tamil Nadu. It is suggested that similar collaborative surveys should be extended to the other States. The culture experiments on *Gracilaria* spp. based on the vegetative propagation by horizontally spread out nets of coir have yielded encouraging results. There is every possibility of increasing production of marine algae by culture methods in the sheltered areas of the sea in our country, after determining the necessary economic feasibility.

10 LEASING OF FISHERY RIGHTS IN PUBLIC WATERS

Leasing Systems

37.10.1 The leasing of fishery rights in public waters* either owned by the State Governments in different departments or by local bodies such as gram panchayats, zila parishads or municipalities, are granted under the following four categories:

(i) Outright leasing system: Leases are granted for one year to seven years on the rentals determined by open auction or by inviting tenders. In granting outright leases preference in most of the States is given to fishermen's co-operative societies (FCS) which in the case of Assam is confined to fishermen belonging to scheduled castes. In the absence of fishermen's co-operatives, preference is given to gram panchayats in some of the States. In most of the States the rentals charged in case of preferential leases are determined either by giving concessions or rebates of varying percentages on the highest bids in the open auction or on the average of the rentals for 3-5 years.

(ii) Royalty system: This is followed only in Madhya Pradesh and Uttar Pradesh for large tanks and reservoirs. Royalty is levied at stipulated rates on the quantities of fish caught and weighed in presence of departmental representatives. In Madhya Pradesh, the royalty rates per kg which are subject to revision whenever considered necessary, are fixed by the Government. In selecting the contracting agency, first preference is given to FCS, failing which to groups of fishermen. In Uttar Pradesh this system, which is followed in case of water impoundments ranging between 80-400 ha, involves inviting tenders for the highest offer of payment of royalty per quintal. Leases are granted for a period of 3 years failing which leases are offered to FCS for a period of 5 years at stipulated royalty rates. If this alternative also fails, the system of open auction is resorted to, and leases are given on annual basis.

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*In dealing with this problem, the main suggestions contained in the Report of the Committee on Leasing Policies of Inland Fisheries, Department of Agriculture, Government of India, 1970 have been taken into consideration.

(iii) Bifurcated leasing system: This is followed only in Uttar Pradesh for large irrigation reservoirs and involves two separate contracts, one for fishing and the other for purchasing or lifting of the catches. In selecting the agency for fishing contracts for 3 years, FCS are given preference if they agree to take up contracts on the payment of wages by the Fisheries Department at 10% more than the lowest tender. Purchasing or lifting contracts are given to the highest tenderer for one year and no preference is given to FCS.

(iv) Licensing system: Licences for period of one year are issued on the payment of licence fees for varying types of gears for fishing in rivers, estuaries, backwaters and large reservoirs. Permits for angling are also issued for shorter durations including single day permits.

37.10.2 The terms and conditions govering leases in the various states include:

(i) safeguards to prevent damages to the various types of structures;
(ii) prohibiting the use of fishing gears for catching fish below specified sizes;
(iii) releasing back juveniles captured;
(iv) allowing inspection of catches and catch records; and
(v) in certain States, stocking of seedfish.

37.10.3 The Committee on Leasing Policies has pointed out the following shortcomings in the present leasing practices:

(i) poor linkage with developmental needs.
(ii) short range view of State Governments in ensuring maximum fisheries revenue.

(iii) leases favouring individuals capable of paying rentals,

(iv) vested interests of fish merchants in utilising FCS as a means of obtaining preferential leases,

(v) unauthorised sub-leasing by individuals or FCS in several cases, and

(vi) handicaps in the effective utilisation of culture fishery resources owing to the short span of lease periods and absence of the fish farming community.

The shortcomings in the present practices of granting fishery rights seem to point out that the State Governments have been pursuing by and large a short range policy of deriving as much fishery revenue as possible. The practices followed have also not given due regard to the developmental activities as well as the socio-economic uplift of the weaker sections of the community engaged in inland fisheries, except for some consideration by way of preferences in granting leases to FCS on concessional lease amounts. The primary consideration in granting fishery rights in public waters should be the long range interest of strengthening the base for increased production with necessary steps favouring the developmental activities and improving per capita productivity. This would help in raising the economic standard of the weaker sections of the community engaged in fishing and increasing fishery revenue accruing to the State Governments.

Transfer of Fishery Rights of Governmental Waters to the Fisheries Departments

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37.10.4 The ownership of the water resources belonging to the State Governments is vested in different departments viz., Revenue, Irrigation, Fisheries and Forest. The fishery rights of the governmental water resources are being leased out by the respective departments. Because of this diversity in the administration of granting leases, there is no co-ordination in evaluating progress and identifying the required developmental activities. The State Fisheries Departments, consequently, experience difficulty in presenting an overall picture of inland fisheries development, including the income derived therefrom. It is, however, implied that conservation of natural fisheries, their scientific management, promotion of aquaculture and the accountability for the results of developmental activities would be the responsibility of the Fisheries Departments. But the accountability seems to be neither of the Fisheries Departments nor that of the other Departments. If the fishery rights of the inland water resources are transferred to the Fisheries Departments it would be possible to effectively co-ordinate the work pertaining to leases in relation with the developmental work and to present an overall picture of the developmental activities, including income, for necessary evaluation and follow up action. It is in this context that the Central Board of Fisheries in its third meeting in 1962 and the Committee on Leasing Policies of Inland Fisheries had recommended the transfer of the fishery rights of inland fisheries resources to the Fisheries Departments. It has been reported that the fishery rights have been transferred in some of the States. It is, therefore, recommended that fishery rights of inland water resources, including those situated in reserve forests and subject to rules governing the activities within the reserves forests, should be transferred to the Fisheries Departments in the other States also.

Granting of Fishery Rights in Different Types of Governmental Waters

37.10.5 Rivers, canals, estuaries, backwaters and lakes: These resources constitute capture fisheries. The granting of fishery rights of these waters would mainly take into consideration the principle of rational exploitation by scientific management of the resources and undertaking conservation measures for protecting the natural fisheries for obtaining maximum yield on a continuing basis. The present practices of granting fishery rights followed in different States fall under four categories as given below:

(i) free fishing, involving no issue of licences as in Maharashtra;

(ii) fishing permitted by issue of licences on the payment of varying amounts of fees for the operation of different types of gears only in notified waters as in Tamil Nadu, under the provisions of the Indian Fisheries Act, 1897, and Madras Act I of 1929;

(iii) fishing permitted by issue of licences without any licence fee in specified waters as in Andhra Pradesh under the provisions of Indian Fisheries Act, 1897; and

(iv) auctioning of notified stretches of waters and issue of a licence to a lessee who has to issue permits for undertaking fishing on his behalf as in Haryana and Punjab, under the Indian Fisheries Act, 1897 and Punjab Fisheries Act, 1914.

In addition of the above there may be provision in the rules for issuing licences for collection of spawn, fry and fingerlings from rivers declared as sanctuaries as in Assam for example.

37.10.6 Granting fishery rights in notified waters by a licensing system would facilitate introduction of restrictions concerning gear, fishing seasons, fishing effort, protection of brood fish and juveniles and regulation of spawn collection in spawn bearing stretches. The whole trend of the fishery could thus be kept under observation and review. It is, therefore, considered that the system of issuing licences for a period of one year, with or without nominal licence fee, to individual members or groups of members sponsored by the fishermen's co-operative societies failing which, to bonafide fishermen, should be adopted. The States in which provisions have not been made under the Indian Fisheries Act, 1897, for notifying waters for issue of licences should take the necessary legal measures for introducing such a system.

37.10.7 Reservoirs, *beels, mans* etc.: The reservoirs having natural fisheries including that of major carps breeding naturally in them and the self stocked *beels. mans* and *jheels* would constitute capture fisheries. The principle governing the grant of fishery rights in these waters would be the same as the case of other capture fisheries. In the case of reservoirs in which natural breeding of major carps takes place, there would be an additional aspect of scientific management to take the best advantage of natural breeding and rearing of seedfish for stocking in the reservoirs and diverting the surplus stock for cultural purposes. There are a large number of reservoirs which have natural fisheries besides those of major carps, but for enriching production the fingerlings of major carps are being stocked year after year expecting natural breeding to take place after some years. The granting of fishery rights in the stocked reservoirs should provide for limiting the catch of even adult major carps so as to conserve adequate numbers for breeding. Such reservoirs would constitute culture fisheries so long as repeated stocking is called for. The practice as followed now in granting fishery rights in such waters comprise all the four systems viz., licensing (e.g. Mettur Dam in Tamil Nadu), royalty (some of the reservoirs in Uttar Pradesh and in Madhya Pradesh), bifurcated leasing (some of the reservoirs in Uttar Pradesh), and outright leases (almost all the States). In following the licensing system it is proposed that this should be adopted on the lines already suggested for other caputre fisheries. The royalty and bifurcated leasing systems could be adopted depending upon the availability of the departmental staff for inspecting the quantity of catches. In adopting royalty, bifurcated and outright leasing systems the following modifications are suggested on the basis given by the Committee on Leasing Policies:

(i) Royalty system: In granting fishery rights, preference in issuing permits for one year with royalty rates upto 30 per cent of the average wholesale price of fish caught should be given to individual members or groups of members of FCS, and bonafide fishermen, failing which auction or tender procedure may be adopted for leasing out for one year.

(ii) Bifurcated leasing systems: Preference in giving contracts for fishing as well as lifting produce should be given to FCS. The former on the payment of fishing charges by the Department on not less than 30% of the gross sale proceeds or calculated on average rate per kg obtaining during the previous year or at the current level of wages. For the produce FCS should make payment to the Department at 50 per cent of the wholesale rates in the previous year. Failing this, either open auction or inviting tenders for both the contracts may be resorted to.

(iii) Outright leases: Preference in granting fishing rights should be given to FCS for a period not exceeding five years on the basis of rentals based on the average of past 3-5 years subject to a maximum of 25 per cent of the estimated yield. Failing this the system of open auction or inviting tenders may be followed and the lease period should not exceed five years.

37.10.8 Tanks and ponds: The principle underlying the lease of culture fisheries in ponds and tanks, including reclaimed units in the marginal areas of *bheels, jheels,* etc., should be to bring about effective utilisation of these resources for maximum per hectare production. In this context, it has to be appreciated that exercising control through private ownership, whether it is land for agriculture or water resource for aquaculture, would by itself be an incentive in the form of a secure-holding to make use of improved technology to maximise production. With the ownership of the public waters being vested either in the Government or in the local bodies, it is considered that a long lease period would be an incentive for undertaking the requisite developmental activities. The present lease periods are so short that the lessees are not able to take advantage of long-term credit facilities for improving fisheries. In the case of production units to be reclaimed from swamps it has been shown that intensive fish production in such units would be possible if the period of repayment of capital is a minimum of 10 years. The Committee has suggested a lease period of 15 years for ponds and tanks with further extension in case of satisfactory progress, and hire-purchase system for newly constructed production units in swamps. In determining the period of leases the main considerations should be the volume of the capital investment in relation to the period of repayment and an additional period for the sustenance of the interest of lessees to bring the waters under intensive fish culture. We, therefore, recommend that the period of lease should be somewhat flexible and left to the discretion of the States and may not necessarily be limited to 15 years. The provision for giving extension of leases should be an important feature not only as an incentive to the lessee but also to reduce the administrative load of work in frequent renewal of leases.

37.10.9 In connection with the rentals from the culture fishery resources, the Committee suggested that these should be equivalent to the land revenue levied on the lowest types of agricultural lands or the lease amounts charged for fallow government lands given for agriculture in the neighbourhood. The areas of the water resources for the levy of fishery rentals should either be the extent of water in the month of April or the average of the maximum and the minimum waterspreads. The principle of the equivalence of land revenue and fishery rentals would need some consideration with reference to its validity. The equivalence of land revenue, whatever may be the varying basis for assessment in different States, could be valid only if there were no bias with regard to the rate of per hectare production in different extents of waterspreads. In crop production, whether the assessee holds one hectare of land or larger areas, it is implied that the potential of production of the same crop would not make any significant difference. But in case of culture fishery resources, the per hectare production would proportionately decrease as the area increases and as such it would not be justifiable if uniform per hectare levies equivalent to land revenue for small as well as larger waterspreads are charged. Besides, the land revenue estimates generally take into account the land ratings on soil classification, produce and price of the produce, but these could not be rated for estimation of fishery rentals. However, the rating of different categories of culturable waterspreads viz., upto 5 ha, 5-10 ha, 10-25 ha, 25-50 ha, 50-100 ha and above 100 ha, or any other modified category considered suitable by estimating fish yield and the price realised, may be used for working out the fair amount of rentals.

37.10.10 Another important feature suggested by the Committee is the need for creating a category of fish farmers by imparting training in improved technology of fish culture to the candidates deputed by the FCS, local bodies if interested in undertaking fish culture by themselves in their own waters and individuals interested in making fish culture their livelihood, and then organising co-operatives of fish farmers.

37.10.11 Considering these important features in granting outright leases of culturable fishery resources, we recommend that preference should be given to fish farmers co-operatives, which have at least two members trained as fish farmers, followed by trained fish farmers sponsored by FCS and individuals trained as fish farmers. These should be long-term leases so that the lessees can make use of long term credit facilities for developmental activities and there should be provision for extension of lease periods on satisfactory fulfilment of lease conditions.

Leasing of Fishery Rights of Water Resources Vested in Local Bodies

37.10.12 Fishery rights of most of the water resources vested in the local bodies such as *gram panchayats*, zila parishads and municipalities are leased out on the basis of outright leasing systems, either by preferential leases or by open auction. The procedures to be followed by this have been laid down only by some of the State Governments. The majority of the water resources are owned by the *gram panchayats.* In some States, *gram panchayats* are also given preferential leases; in several such cases the water resources are subleased unauthorisedly to FCS or individuals. In a few cases, *gram panchayats* themselves undertake fish culture activities; it has, however, been reported that except in some cases the performance of most of the *gram panchayats* has left much to be desired. This is due to the fact that the *gram panchayats* are engaged in multifarious activities and are not in a position to spare adequate funds for fish culture activities or for engaging the services of necessary technical people. We feel that fishery rights of waters vested in local bodies need not be transferred to Fisheries Departments. The procedure in leasing out fishery rights by the local bodies may also be on the lines outlined for governmental water resources. In the case of local bodies proposing to undertake developmental work by either engaging trained persons or by deputing their own personnel for training, the State Governments could accept such schemes which have been duly approved by the Fisheries Departments beforehand.

Leasing out Portions of Larger Waterspreads for Aquaculture.

37.10.13 It is envisaged that the developments in aquaculture in the next 25 years would involve the use of floating net enclosures, rafts etc. in larger waterspreads, particularly freshwater reservoirs, canals, brackishwater lakes and inshore areas of the sea for the production of fish, shellfish, culture pearls and marine algae.

37.10.14 As the construction of reservoirs affects the riverine fishermen of the area and others whose land gets submerged, aquaculture in floating devices that occupy small portions of reservoirs would offer an opportunity of rehabilitation of the affected persons after necessary training. This would, therefore, necessitate giving first preference in leasing out portions of reservoirs for aquaculture operations to the persons affected by reservoir impoundments, after organising them into co-operative societies. Failing this, leases may be given as in the case of culture fishery of ponds and tanks. In the case of leasing out brackishwater lakes, the leases may be given as in the case of culture fishery of freshwater ponds and tanks. As regards leasing out portions of inshore seas and lagoons, consideration has to be given to marine fishermen as well as others, as the industry would also embrace production of some of the marine products by mariculture. The lease periods and rentals may vary according to the commodity under culture and its duration; but these should be favourable enough to attract entrepreneurs.

11. ORGANISATIONAL ASPECTS

Seedfish Production and Supply in the States

37.11.1 It has been estimated that the present production of about 20,000 tonnes from about 3.0 mha of reservoirs could be increased to at least 120,000 tonnes by establishing major carps fishery. In the next 25 years, the capacity of the reservoirs and the potential for production are expected to increase twofold.

37.11.2 To enrich the reservoir fishery with the major carps, there would be a need to build up seedfish production capacity of nearly 3,000 m fry (to give 1,500 m fingerlings). For achieving this, 1,200 ha of seedfish farms would be needed and the main reliance would be on induced breeding methods. The construction of this capacity of seedfish farms would involve an investment of about Rs. 9 crores which would eventually result in an additional annual fish production of about 200,000 tonnes valued at Rs. 60 crores at 1972 prices. However, since the reservoirs are to be stocked with fingerlings and not fry, about 60,000 ha of rearing tanks, involving an additional investment of Rs. 9 crores would be necessary. To avoid this, the introduction of floating net enclosures has been suggested, which could be used in the reservoirs themselves. Seedfish production for the reservoir fishery should be the function of the State Fisheries Departments, which would be required to build up the necessary capacity, taking into consideration the area of reservoirs in each State.

37.11.3 It has been estimated that about 3,000 million fry per annum would be required for raising the density of stocking. It has also been projected that by reclamation of 0.1 mha (about 25 per cent of the available area) of freshwater swamps into small farming ponds, the inland fish production could be increased by another 0.5 million tonnes, but this needs additional seedfish production of about 1,000 million fry. It may be reasonable to assume that 50 per cent of 4,000 million fry required for culture fisheries would, in due course, come from rivers and dry and wet bunds. For the remaining 2,000 million fry, additional capacity of 800 ha of seedfish farms, involving capital investment of Rs. 6 crores, will have to be built up. Considering that seedfish production by hypophysation could be an economic proposition, this activity could also be taken up by the State Fisheries Corporations or by private enterprise.

37.11.4 The new systems of aquaculture, comprising the use of different types of devices such as floating net enclosures, rafts etc., in larger waterspreads such as reservoirs, canals and lakes, have the potential of making the maximum contribution to inland fish production. But the contribution would be subject to the limitation of artificial feeds available. The freshwater seedfish required for intensive culture in these systems, which would mostly be that of common carp, could easily be produced during the months when seedfish of major carps are not being produced.

37.11.5 The establishment of freshwater seedfish farms of nearly 2,000 ha on an average of about 6 ha per district, would thus constitute the most important function of the State Fisheries Departments. Such farms would also be useful as centres for adaptive research and extension work, particularly for conducting field trials and demonstrations, as these aspects have so far been neglected in the States. This activity in districts would justify additional farm staff under a Seedfish Production Officer in charge of the farms.

37.11.6 Brackishwater fish culture could make a contribution of additional 300,000 tonnes, if 0.1 mha of the available area of 1.42 mha of brackishwater swamps could be reclaimed into farming units. The collection of brackishwater seedfish from the natural waters, as has already been pointed out, would constitute an important activity. This could take the form of a cooperative society of brackishwater fish culturists, which might be issued licences for collection of seedfish. It might also be possible to supplement seedfish production of some of the varieties under captivity conditions. This could be done by establishing a brackishwater fish farm in each maritime State, which would also serve as a centre for adaptive research and extension work.

Engineering Cell

37.11.7 Aquaculture requires considerable technical assistance in the field of engineering. The workload would comprise planning, designing, cost estimating and construction of some of the works pertaining to seedfish farms. New farming units are to be developed by reclamation from freshwater swamps after restoration of connecting channels and by reclamation of brackishwater tracts aided by construction of stable dykes capable of withstanding tidal impacts. These works require considerable skill in field-engineering which has so far been a neglected aspect of fish farming in India. Efforts to provide engineering help to research Institutes and Fisheries Departments in India have so far failed and this has resulted in valuable scientific knowledge on fisheries remaining unutilised. It would, therefore, be necessary to have an Engineering Cell in the Directorates of Fisheries with requisite technical staff deputed from the Irrigation Department.

Research, Extension and Training

37.11.8 Taking agriculture as an omnibus discipline including fisheries, the aspects of research, extension and training have been dealt with in this Commission's Interim Report entitled "Some Aspects of Agricultural Research, Extension and Training" in which we have made recommendations for the allocation of responsibilities between the agricultural universities and the technical departments in the States. In fisheries the role of agricultural universities has so far been marginal.

37.11.9 To give support to the development of inland fisheries and aquaculture in the country, the facilities in research, extension and training were built up mainly by the Central Government. The research in inland fisheries is being conducted at CIFRI since its establishment in 1947. It has several units and survey centres throughout the country. Research on mariculture is being done at the CMFRI. For extension work, 10 units were established under the first three Plans for disseminating technical information and giving practical demonstration to fishermen, fish farmers, staff of the Fisheries Departments and personnel of the Community Development Blocks. These units established by the Centre were prematurely transferred to the States and in that dormant status were abolished during the Fourth Plan. Since then, the extension work in inland fisheries between the Centre and the States has virtually come to a stop through inaction both at the Centre and in the States, particularly affecting the 'transfer' process in adopting improved field techniques. Absence of adequate work in fisheries extension has been one of the principal reasons for the slow pace of inland fisheries development. Facilities for training were provided at higher, middle and lower levels for in-service candidates of the State Fisheries Departments. Training in inland fisheries constitutes one of the disciplines of an integrated course of two years in Fisheries Science at the Central Institute of Fisheries Education (CIFE), Bombay, for higher level deputees of the State Fisheries Departments who are graduates in science. To middle level technical officers, training course of one year is imparted in inland fisheries at the Inland Fisheries Training Unit (IFTU), Barrackpore, Calcutta. For training at lower level, both for in-service candidates as well as fish culturists with minimum qualifications of a pass in matriculation, two Regional Training Centres for Inland Fisheries Operatives were set up in 1967 at Agra and Hyderabad. Facilities developed at these centres, though far from satisfactory, have not been adequately availed of by the States, probably because of the handicap of the medium of instruction which is English. The Hyderabad Centre has been closed and is being reorganised as a Central Fisheries Extension Training Unit in Fish Culture while the Agra Centre has practically no facilities. Specialised training in extension would comprise two aspects viz., (a) extension methods, techniques etc. and (b) fish culture technology; the latter would be more or less a matter of repetition of training fór qualified candidates from CIFE or IFTU. It is, therefore, suggested that a short-term course only in extension methods in addition to a longer term course comprising extension as well as aquaculture, both theory and practice, be organised at the Hyderabad Centre.

37.11.10 At the State level, there is hardly any research conducted in inland fisheries and aquaculture. It is high time that the States should start taking active interest in this field. The establishment of seedfish farms by the State Fisheries Departments would, however, provide ample scope for developing adaptive research with reference to local conditions.

37.11.11 As regards extension services in the States, the Fisheries Departments have, during Plan periods strengthened their organisations, extending their service in most cases upto district level and in some cases upto sub-district/community development blocks. Their activities comprise mainly establishing and maintaining fish farms, procurement, production and distribution of seedfish, extending technical and financial assistance and granting leases of fishery rights of water resources where the authority is vested in the Directorates.

37.11.12 The primary objective of providing extension services is to develop technical expertise of the State Directorates of Fisheries responsible for better scientific management of capture fishery resources and more effective utilisation of culture fishery resources. There is need for the building up of a communication agency in the form of the extension cells in the research and developmental agencies under the Centre and in the Directorates of Fisheries. The responsibility for communication of improved technology upto the district level would be that of the extension cell in each Directorate. The district level fisheries organisations would be responsible for the extension work in the districts. It would be appreciated that in the districts having adequate resources of inland fisheries and aquaculture there is need for separate extension staff under the district level fishery organisation. The latter would assist the composite functional units, which would be organised as an integrated service in all disciplines of agriculture for extension, training, supplies, credit etc. as suggested in the Chapter 62 on Administration.

37.11.13 The field adoption of improved technology would necessitate training of fishermen and fish culturists with main emphasis on demonstrations and practical management. This training has to be organised at the State level because instruction should be through the regional languages. The arrangement for this training could be made at the seedfish farms by the extension cell in the Directorates in coordination with the district level fisheries organisations, taking the help of technical personnel who have specialised in the relevant subjects so that the training is efficient and the trainees are convinced of the economic advantages of adopting improved technology. As regards training in aquaculture, it can only be useful if there is an assurance of trainees going back to undertake aquaculture in their own water holdings or in those to be allotted to them. The duration of training in fish culture may have to vary. Those trainees who are traditional fish culturists as in Bengal, Bihar and Orissa, would require training only in improved practices of fish culture and not in the conventional practices. Training of such fish culturists may be of the duration of 3-4 weeks. The traditional fishermen making their livelihood from the capture fisheries and others who seek fish culture as an occupation will have to be trained both in the initial aspects and in the improved techniques. Imparting training in both the aspects has, therefore, to be of longer duration and may extend to about 8 weeks.

Employment Opportunities at Production Level

37.11.14 The population of inland fishermen in India, as compiled by the Department of Agriculture, Government of India on the basis of information received from the States, was approximately 774,500 in 1970. The States were not able to furnish information on the break-up of this population into part-time and full-time fishermen. It is generally recognised that the inland fishing community is economically backward. No studies, however, have been undertaken to determine their economic status. Their per capita production and therefore economic status, would not only vary in different aspects of inland fisheries and aquaculture, but would also vary in different States depending upon the costs and returns on the same type of produce. It is, therefore, suggested that necessary studies should be undertaken in the States with a view to raising the economic activity and evaluating the same in relation to the developmental measures.

37.11.15 Amongst all aspects of inland fisheries and aquaculture, the culture fisheries in fresh and brackish waters have the potential of providing the maximum opportunities of employment at production level. It may, first, be necessary to consider what could constitute an adequate employment unit. It has already been shown that a pond of 0.4 ha can pield incomes of Rs. 1,070, Rs. 2,500 or Rs. 1,170 by raising respectively 1,200 kg of major carps, 2,000 kg of composite carps or 1,200 kg of brackishwater fish. Considering the difference in the yield and the income from the same size of pond i.e. 0.4 ha under varying culture conditions, and still larger differences in the yields from ponds of 0.4 ha or area units of that size in a large waterspread unit, it would not be proper to assume an average yield and income in terms of a unit of water holding. It may, however, be reasonable to assume from these estimates that an average production equivalent of 1,000 kg of prime varieties of culturable fish would give an income of about Rs. 1,250 at 1971-72 prices.

37.11.16 We might assume the national desirable minimum level of consumption at Rs. 37 per capita per month at 1971-72 prices or a little over Rs. 2,200 per annum for a family of 5 persons. If a fisherman's family attains a production of 2,000 kg of prime variety of culturable fish in a year, according to the costs and returns (at 1971-72 prices), it will receive an income of Rs. 2,500 per annum which is sufficient to maintain it above the desirable minimum level of consumption. On this basis the production of about 2.8 million tonnes from the culture fisheries of the existing ponds and tanks and new farming units to be reclaimed at the fresh water and brackish swamps will give employment to 1.4 million units. The capital investment on the entire programme would be of the order of Rs. 1,375 crores and the annual turnover would be Rs. 840 crores as indicated below:—

	Existing ponds and tanks	Reclaimed farming units		Total
		Freshwater swamps (25% of the available area of 0·4 mha)	Brackish-water swamps (0·1 mha out of 1·42 mha of the available area)	
1. area (in million ha) .	1·5	0·1	0·1	1·7
2. captial investment (Rs. in crores)	1,125·00 (@Rs.7,500 per ha for repairs etc.)	125·00 (@Rs.12,500 per ha for construction of new farming units)	125·00 (@Rs.12,500 for construction of new farming units)	1,375·00
3. estimated fish production (in million tonnes)	2·0	0·5	0·3	2·8
4. per annum sale proceeds of fish @ Rs. 3,000 per ton (Rs. in crores)	600·00	150·00	90·00	840
5. employment units @ 1 unit =production equivalent of 2,000 kg of fish (in millions)	1·0	0·25	0·15	1·4

37.11.17 The attainment of targets of fish production and employment units, alongwith corresponding development of seedfish production, would require phasing out the programmes in the future Plans, depending upon the financial outlays made available by the government and financial institutions.

37.11.18 Besides, the new systems in aquaculture, particularly the intensive production of freshwater fish in net and cage enclosures in reservoirs and lakes and different aspects of mariculture and increased production from reservoir and estuarine fisheries would provide extensive employment opportunities. It is envisaged that the total production from all inland fisheries resources would go upto 4.5 million tonnes by 2000 A.D.

Institutional Aspect

37.11.19 Inland fisheries co-operatives constitute a major institutional agency involved in fostering the socio-economic condition of the inland fishermen. The number of co-operatives in both the sectors of fisheries, inland and marine, was 2,538 during 1962 according to the Report of the Study Group on Fisheries Co-operatives, 1964. This number had increased to 4,247 during 1969-70 as per the

'Statistical statements relating to the co-operative movement in India-non-credit societies' brought out by the Reserve Bank of India. In the absence of any data available separately on the inland fisheries co-operatives, the number of co-operatives in the major inland states and the maritime States of West Bengal and Orissa, which are also mainly inland fish producing States would be fairly representative. The performance of the cooperatives in terms of respective numbers and percentage showing profit, loss and no profit and no loss in case of cooperatives in 1962 and 1969-70 is given below:

	1962		1969-70	
	Inland and marine	Inland States and West Bengal and Orissa	Inland and marine	Inland States and West Bengal and Orissa
number of co-operatives .	2,538 (100)	1,049	4,247 (100)	1,488 (100)
number showing profit .	991 (39)	..	1,226 (29)	424 (28·5)
number showing losses. .	949 (37)	..	1,962 (46)	419 (28·2)
no-profit-no-loss . .	598 (24)	..	1,059 (25)	645 (43·3)

It can be seen from the above data that there has been a considerable increase in the formation of fisheries co-operatives during 7 years period under review. As regards performance, it is seen that the percentage of societies showing profits had decreased from 39 in 1962 to about 29 in 1969-70 indicating that the unsatisfactory performance by the co-operatives had not only continued but had even worsened during the period.

37.11.20 The reasons generally attributed for this situation are the vested interests in the cooperatives with a predominance of a few resourceful and influential members, some of whom are not even producers themselves, as well as inefficient management. There has also been a tendency towards proliferation of numbers of the inland co-operatives merely to take advantage of the concessional rates of preferential leases of water resources and other concessions granted to them by the State Governments.

37.11.21 The continuous poor performance of inland fisheries co-operatives calls for surveys in the States to identify viable and non-viable units. It seems that in constituting and developing these co-operatives which carry out different types of activities e.g. credit, supply of requisites, production and marketing, no adequate consideration has been given to make them economically viable. It has to be understood that the governmental measures to promote and assist the inland fisheries co-operatives are being adopted to increase economic efficiency of the co-operatives so as to eliminate governmental support in due course. It is, therefore, suggested that in the States fostering the development of inland fisheries co-operatives the concerned departments should identify the minimum scale of economic operations for conducting different types of inland fisheries activities to decide the necessary measures of assistance to the existing non-viable units.

37.11.22 The enterprise of inland fishermen, whether in capture or culture fisheries, constitutes in most cases a collective activity. Even in cases of small units of culture fisheries managed by individuals, there would be need for co-operative or group effort in undertaking netting for examining the fish periodically and for taking out the produce for marketing, saving thereby necessary expenditure every time on engaging the labour. The collective activity being a common feature in inland fisheries and aquaculture, it can be stated that this activity could best be managed under a co-operative system. It has also been stated that the co-operatives should receive preference in allotting the leases of water resources. As such the co-operatives have an important role in the production of inland fish.

37.11.23 An important aspect of the co-operatives to attain economic viability would be to make the process of fish production more efficient by increasing output at minimum cost of inputs. It has been stated that per capita production of fishermen engaged in inland fisheries is low and that the fishermen are under-employed. The basic consideration would, therefore, be to examine the possibility of providing adequate means of production to the co-operatives to ensure for each member the level of minimum economic activity to become economically viable. In considering this, it would be advisable if the production activities of the primary co-operatives are specifically oriented towards either capture or culture fisheries. This would help in first determining and then providing adequate means of production at the disposal of the co-operatives in proportion to the strength of the members. Two types of co-operatives would also be advisable from the point of view of better management in production activities as also for following the organised programmes of developmental measures and the application of improved technology. There may, however, be areas where organisation of separate societies may not be possible because of inadequate activity in each of the two types of fisheries. In such cases, each type of production activity under the auspices of a co-operative can take the form of a separate occupational group. The reorganisation of existing co-operatives or the formation of new co-operatives in the areas not already covered by two types of co-operatives would in the first instance necessitate framing model bye-laws by the Centre, keeping in view the respective emphasis on the aims and objectives of capture and culture fisheries.

37.11.24 Another important aspect of economic activity of inland fisheries co-operatives would be proper marketing of fish so that the primary producers get the maximum economic advantage within the prevailing price structure. It would, therefore, be necessary that the marketing of the produce should also be organised through the co-operative structure. Despite the fact that need has all along been felt for rational development of co-operative marketing of fish, the progress has been slow. The major obstacle has been the dominance of the middlemen in the marketing system particularly in West Bengal and some of the States in the eastern sector where the demand for inland fish is highest in the country. The middlemen in the prevalent system are chiefly responsible for manipulating wholesale and retail prices of fish to their advantage. They even offer very high prices to the producers as a temporary phase so as to eliminate the co-operatives in the process. There have been several instances when the fish merchants and middlemen have joined hands to liquidate marketing or distribution systems developed by the fishermen co-operatives by offering temporary inducements to them. As such, an important factor in marketing fish through co-operatives would entail the necessity of binding the members and member-co-operatives by a suitable provision in the bye-laws obliging them to market their produce exclusively through the co-operatives.

37.11.25 In marketing the produce, the co-operatives may have to make immediate payments to the producers, whereas they may have to wait for some time to realise their dues from the wholesalers or retailers. The working funds required should be made available to the marketing co-operatives by the co-operative banks or the Government.

12 SUMMARY OF RECOMMENDATIONS

37.12.1 The main recommendations are given below:

1. Fisheries from inland waters should be developed as a priority industry because of the high demand and market value for fresh and brackishwater fish which could be raised and distributed as low-cost protein food.

(Paragraph 37.1.6)

2. Improvements in capture fisheries will be possible only through refinements in fishing techniques which should be solved by Craft and Gear Research section of the CIFT (ICAR).

(Paragraph 37.2.4)

3. The fisheries organisations in the States should effectively manage fishing operations in rivers through appropriate regulations to conserve stocks.

(Paragraph 37.2.5)

4. While Indian major carps (*rohu, catla* and *mrigal*) form the principal yield of the river systems of the Indo-Gangetic Plains, greater reliance should be placed on indigenous species in the rivers of Peninsular India.

(Paragraphs 37.2.3 and 37.2.6)

5. To stem the rapid decline of the *Hilsa* fisheries, particularly of the northern rivers, suitable measures of conservation should be formulated and enforced without delay. Research work on establishing *Hilsa* culture should be intensified by ICAR.

(Paragraphs 37.2.8, 37.2.9,
37.7.52 and 37.7.53)

6. Improvements in trout hatchery practices should be introduced for higher survival rate of seedfish to enable more intensive stocking in the existing trout streams and for establishing new fishery areas in Jammu-Kashmir, Himachal Pradesh and other high altitude regions. Breeding and hatchery practices should be developed towards the production of seedfish for undertaking commercial culture in suitable cold water areas.

(Paragraphs 37.2.13 and 37.7.50)

7. Considering the importance of mahseer as a top-class commercial and sport fish there is need for extensive surveys and investigations on different species of mahseer for establishing viable capture and culture fisheries.

(Paragraphs 37.2.17 and 37.7.51)

8. Pre-impoundment surveys of rivers should help formulate proposals for developing reservoir fisheries and for preserving downstream iothyofauna. The proposals should be jointly developed by Fisheries and Irrigation Organisations in the States for inclusion in the river valley projects, and the required works should then be got done prior to impoundment.

(Paragraphs 37.2.7, 37.3.3,
37.3.4 and 37.3.6)

9. Reservoirs and tanks built for domestic water supplies should also be utilised for fish rearing but with adequate health safeguards.

(Paragraph 37.3.8)

10. To keep the continuity of stocks of major carps which take long periods of acclimatisation for natural breeding, it should be ensured that the adequate level of water is maintained in the dead storages of medium and major reservoirs.

(Paragraph 37.3.9)

11. Fishing in the reservoirs should be rationalised by systematic removal of trash fish and observing closed seasons to stop indiscriminate killing of broodfish, particularly of major carps.

(Paragraphs 37.3.11 and 37.3.12)

12. To maintain the productivity of reservoirs, the possibility of cultivating suitable types of legumes in the foreshore areas exposed during summer months should be explored. The top cuttings of these crops would be useful as green fodder.

(Paragraph 37.3.14)

13. The State Governments, while formulating the policy for land and water utilisation, should consider freshwater swamps as naturally advantageous areas for the development of fisheries and other uses, if any, should be treated as subsidiary.

(Paragraph 37.4.3)

14. To improve production from capture fishery of estuaries, regulations for fishing and 'closed seasons', if necessary, should be adopted for the coastal districts by the maritime States.

(Paragraph 37.5.11)

15. To restore the fall in production from the capture fishery of brackishwaters, particularly in Chilka and Pulicat lakes, as a result of silting of the connection with sea, and to maintain the level of agricultural and fisheries production in the entire area, integrated plans should be developed by coordinated action on the part of Irrigation, Agriculture and Fisheries Departments.

(Paragraph 37.5.9)

16. The production base by aquaculture from fresh, brackish and sea waters should be enlarged with the application of new technology.

(Paragraphs 37.6.6 and 37.6.7)

17. The seedfish supplies of major carps have to be increased several fold by all methods of production for undertaking increased stocking densities to obtain optimal yields from all culturable waters.

(Paragraph 37.7.9)

18. Necessary conservational measures should be undertaken to protect breeding grounds of major carps. Riverine stretches which harbour large scale concentrations of seedfish should be kept only for seedfish collection.

(Paragraph 37.7.12)

19. The State Governments should intensify investigations to locate as many wet bunds as possible for increasing seedfish production. Central fisheries agencies should undertake detailed investigations in collaboration with the States where wet bunds are being exploited, to identify the factors responsible for the success of natural breeding of the major carps in the wet bunds, so as to help in bringing about the natural breeding in as many stocked perennial waters as possible by providing the optimal conditions.

(Paragraph 37.7.15)

20. States should expand the facilities for dry bunds breeding of major carps after surveying suitable areas where they could be constructed at the minimum cost, with a view to increasing seedfish production, as has been done in Madhya Pradesh.

(Paragraph 37.7.16)

21. Considering the quality of seedfish produced through induced breeding by giving injections of pituitary hormones or suitable substitutes, the States should considerably intensify the programmes for seedfish farms located near reservoirs and other areas where perennial water facilities exist.

(Paragraph 37.7.20)

22. To meet the mounting demand of injection material in the circumstances of shortage of pituitary glands experienced even at the present level of activity, the ICAR should intensify research on fish gonadotropins in collaboration with the universities and pharmacological laboratories in India where allied work is being done, so as to expedite the process of finding out suitable substitutes.

(Paragraph 37.7.22)

23. The frequency of success in induced breeding method being dependent on favourable environmental factors, not yet clearly defined, the ICAR should intensify studies, on this relationship with a view to establishing the exact environmental factors necessary for success.

(Paragraph 37.7.23)

24. The States should increase available area for nursery tanks and adopt improved management practices developed by ICAR in fish nurseries. There is need to bring out relevant extension literature and organise training-cum-demonstration in these practices. Floating fish nurseries can be of considerable advantage when adequate space for ground nurseries is not available. The ICAR should study the possibility and economic feasibility of adopting floating nurseries.

(Paragraphs 37.7.24 and 37.7.25)

25. Wherever stocking of fingerlings is considered necessary, the States should give preferential consideration to grant fallow lands near culturable waters for creating rearing ponds. The possibilities of rearing fry to fingerlings on artificial feeds in net enclosures of synthetic material should be examined by the ICAR.

(Paragraph 37.7.26)

26. For experimental work on indigenous and exotic carps in areas potentially important in fish culture, the establishment of large fish farms for adaptive research is recommended for each State.

(Paragraph 37.7.28)

27. As the use of fertilisers in raising productivity of ponds and tanks has to be rational and economic, the ICAR should intensify studies on the uses of different types of fertilisers as applied to fish culture under different conditions. While setting up a service for soil and water analysis the State Fisheries Departments should entrust it with an advisory role on use of fertilisers also.

(Paragraph 37.7.31)

28. Considering the important role of artificial feeds in increasing production by aquaculture, the ICAR should step up research on utilisation of cheap or waste materials for artificial feeds, which should be available in large quantities and could be easily stored.

(Paragraph 37.7.32)

29. With the increased stocking density of seedfish of carps in right proportion for optimal utilisation of natural feeds and with the introduction of fertilisers and artificial feeds wherever intensive cultural practices are economically feasible, the States should see that these water resources are put to maximum utilisation thereby increasing the base of carp production several times.

(Paragraph 37.7.34)

30. Introduction of large scale monoculture of common carp in net enclosures kept afloat in reservoirs, canals etc. to substantially increase inland fish production seems to be a promising line to be developed in the country. This system has also significance in solving to some extent the problem of rehabilitation of people displaced as a result of impounding reservoir basins. The ICAR should find out the most economical types of enclosures to enable the introduction of this system of fish culture.

(Paragraphs 37.7.47 and 37.7.48)

31. Freshwater swamps, unsuitable for economic reclamation into farming units for carp culture, should be increasing utilised for culture of air breathing fishes.

(Paragraph 37.7.49)

32. The maritime States should undertake detailed surveys of brackishwater swamps for mapping out suitable areas for reclamation into farming units, and carry out systematic prospecting of brackishwater resources for seedfish. To supplement seedfish production under captivity conditions, ICAR should intensify research on artificial breeding of mullets and other estuarine species.

(Paragraphs 37.8.2 and 37.8.19)

33. Maritime States should undertake, in co-ordination with research agencies, pre-investment studies on brackishwater culture by establishing experimental and pilot commercial fish farms at selected centres.

(Paragraph 37.8.20)

34. The maritime States should undertake surveys of coastal regions for locating productive areas for culture of molluscan shellfish, mainly edible oysters, mussels and clams. The most economical methods of cultivation should be evolved for adoption in the States. Alternative use of mussels, constituting the most productive form of mariculture, should also be examined, particularly their reduction into mussel-meal, for livestock and poultry feed.

(Paragraphs 37.9.5, and 37.9.8 and 37.9.10)

35. Priority consideration should be given by ICAR to the furtherance of indigenous technology of culture pearl industry with a view to establishing its economic viability and its early development as a commercial undertaking, particularly of Tamil Nadu and Gujarat, where the pearl oyster beds have become unproductive for the extraction of natural pearls. New developments in spat collection for pearl oysters in Kerala appear promising.

(Paragraph 37.9.17)

36. ICAR should bring out necessary extension literature on the technique and economics of the culture of marine algae, so that the industry based on these algae as raw material can take advantage of new technology developed by the appropriate institutes of ICAR and CSIR.

(Paragraph 37.9.24)

37. In granting leases of fishery rights in public waters, State Governments should take a long-range view of enlarging the base for increasing inland fishery production with necessary steps favouring development activities.

(Paragraph 37.10.3)

38. Fishery rights of inland water resources, now vested in other departments of the State Governments, should be transferred to fisheries Departments.

(Paragraph 37.10.4)

39. For fishing in rivers, canals, estuaries and backwaters, a licensing system should be adopted in the States after notifying waters under the necessary legal provisions.

(Paragraph 37.10.6)

40. For fishing in reservoirs, *beels*, *jheels* etc. any system—licensing, royalty, bifurcated leasing, or outright leasing—may be adopted keeping in view the conditions laid down for each system.

(Paragraph 37.10.7)

41. Rights in culturable fisheries should be granted as outright leases on adequate tenures to enable utilisation of long term credit. There should be a provision for extension of lease periods on satisfactory fulfilment of lease conditions, and on fair amount of annual rentals based on rating water spreads into suitable categories on the basis of estimated yields and price of produce.

(Paragraph 37.10.11)

42. In leasing out fishery rights of waters vested in local bodies such as municipalities, gram panchayats, etc. similar procedure as for governmental waters should be adopted. However, local bodies interested in undertaking developmental activities themselves should either engage trained persons or get their personnel trained, and the State Governments should then accept such schemes duly approved by the Fisheries Departments.

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(Paragraph 37.10.12)

43. In leasing out portions of reservoirs, canals, lakes and coastal region for intensive aquaculture in new systems such as floating net enclosures, cages, rafts etc. same procedure should be adopted as for culture fisheries, except that in case of reservoirs first preference should be given to persons affected by impoundments and in case of coastal region consideration should also be given to any private enterprise including the corporate sector.

(Paragraph 37.10.14)

44. Engineering Cells and Extension Cells should be developed in the research and developmental agencies at the Centre and in the Fisheries Directorates in the States.

(Paragraphs 37.1.7 and 37.11.12)

45. Training in field adoption of improved technology should be organised at the State level, with the main emphasis on demonstration and practical management.

(Paragraph 37.11.13)

46. The Centre should frame model bye-laws for two types of Fisheries Co-operatives laying emphasis on capture or culture fisheries separately, but with the common proviso making the marketing of catches by the members through the co-operatives an obligatory feature. Necessary credit for marketing should be made available to the co-operatives. The States should identify the minimum scale of economic operation for inland fisheries co-operatives and work out the scales of necessary assistance to the new and existing units.

(Paragraphs 37.11.21, 37.11.22
and 37.11.25)

APPENDIX 37.1

(Paragraph 37.1.4)

Production of Inland Fish State-wise

('000 tonnes)

Name of the state/union territories	Triennial averages				Percentage contribution to the total	Maximum production	
	1961-63	1964-66	1967-69	1970-72		qty.	year
1	2	3	4	5	6	7	
West Bengal	41·21 (100)*	119·19 (289)	198·33 (481)	229·00 (556)	33·96	233·00	(1969)
Tamil Nadu	60·69 (100)	102·04 (168)	119·39 (197)	107·29 (177)	15·91	131·00	(1969)
Andhra Pradesh	78·77 (100)	88·19 (112)	83·38 (106)	87·55 (111)	12·98	95·65	(1969)
Bihar	50·14 (100)	42·93 (86)	48·67 (97)	58·00 (116)	8·60	60·00	(1972)
Karnataka	32·38 (100)	40·00 (123)	44·73 (138)	55·18 (170)	8·18	63·52	(1971)
Assam	12·11 (100)	17·92 (148)	25·15 (208)	27·00 (223)	4·00	28·10	(1972)
Uttar Pradesh	9·07 (100)	10·74 (118)	15·19 (168)	21·58 (238)	3·20	22·34	(1972
Orissa	18·40 (100)	13·11 (71)	25·17 (137)	20·17 (110)	2·99	25·50	(1969)

Kerala	1·09 (100)	5·54 (508)	7·73 (709)	14·19 (1302)	2·10	17·80	(1971)
Gujarat	0·06 (100)	6·72 (11200)	10·93 (18216)	13·82 (23000)	2·05	15·10	(1971)
Maharashtra	10·75 (100)	12·01 (112)	13·22 (123)	13·57 (162)	2·01	13·80	(1972)
Madhya Pradesh	5·22 (100)	6·37 (212)	7·70 (148)	8·43 (162)	1·25	8·70	(1972)
Jammu & Kashmir	1·99 (100)	4·21 (212)	4·79 (241)	6·69 (336)	0·99	7·59	(1972)
Tripura	1·23 (100)	3·37 (274)	3·65 (297)	3·87 (315)	0·57	4·13	(1972)
Rajasthan	1·87 (100)	2·95 (158)	5·00 (267)	2·80 (150)	0·42	6·70	(1970)
Punjab	6·24@ (100)	3·91@ (63)	1·66 (27)	1·85 (30)	0·27	6·42	(1964)
Manipur	0·63 (100)	3·01 (478)	0·69 (110)	1·07 (170)	0·17	1·20	(1971)
Haryana	..	–	0·71	0·70	0·10	0·95	(1972)
Himachal Pradesh	0·26 (100)	0·24 (92)	0·56 (215)	0·71 (273)	0·10	0·72	(1970)
Pondicherry	0·07 (100)	0·16 (229)	0·24 (343)	0·39 (557)	0·07	0·43	(1972)
Delhi	0·16 (100)	0·17 (106)	0·18 (113)	0·19 (119)	0·03	0·19	(1970)
Arunachal Pradesh	..	..	0·13	0·17	0·03	0·17	(1970)
Nagaland	..	..	0·05	0·11	0·02	0·12	(1970)

APPENDIX 37·1 (contp.)

1	2	3	4	5	6	7
Goa	..	..	..	..	..	1·49 (1972)**
Meghalaya	..	..	..	..	..	0·70 (1972)**
Mizoram	..	..	..	..	..	0·18 (1972)**
total .	332·34 (100)	482·78 (145)	617·25 (186)	674·33 (203)	100·00	693·2 (1969)

@Combined figures for Punjab and Haryana.
*Percentages.
**Figures available for 1972 only.

APPENDIX 37.2

(Paragraph 37.7.19)

Economics of Seedfish Production

(A) Unit of seedfish production of major carps by hypophysation during monsoon	5·0 m fry =(10·0 m spawn)
(a) Quantity of broodfish required	1200 kg/720 No.
(i) 5 kg of females can produce 0·25 m spawn (3 kg *catla*, 1 kg *rohu*, 1 kg *mrigal*)	
(ii) to produce 10·0 m spawn females required.	200 kg/120 No.
(iii) 2 males per set, therefore males required for 120 sets.	400 kg/240 No.
(iv) broodfish for 120 sets	600 kg/360 No.
(v) no. of sets to be doubled because of only 50 per cent success.	1200 kg/720 No.
(b) Quantity of donor fishes required	400 kg
(i) pit. glands for injection females 400 (kg) × 10mg/kg.	=4000 mg
(ii) pit. glands for injecting males 800 (kg) ×3 mg/kg.	=2400 mg
	6400 mg
(iii) pit. glands available from spent fish 1200 (kg) ×4 mg/kg.	=4800
(iv) balance of 1600 mg to be obtained from 400 kg if donor fish @ 4 mg per kg.	
(c) Broodfish and donor fish required	1600 kg.
(B) Economics :	
(a) Cost :	
(i) annual repayment of capital investment of Rs. 1,25,000 on seedfish farm of 1·5 ha (10 equal instalments).	Rs. 12,500
cost of land	Rs. 25,000
cost of construction of ponds	Rs. 40,000
cost of construction of laboratory room, store room etc.	Rs. 60,000
	Rs. 1,25,000
(ii) average annual interest on capital	Rs. 6,250
(iii) cost of raising brood and donor fish 1600 kg @Rs. 2/- per kg.	Rs. 3,200
(iv) annual expenditure/on recurring and depreciation on non-recurring items of equipment.	Rs. 7,500
(v) salary of one Technical Assistant @ Rs. 600/-p.m.	Rs. 7,200
(vi) salaries of one fieldman and watchman each at Rs. 300/- p. m.	Rs. 7,200
(vii) charges on account of labour employed during breeding season.	Rs. 4,000
(viii) cost of nursing 10·0 m. spawn to 5·0 m fry, taking 50 per cent mortality.	Rs. 2,500
(ix) water charges, repairs etc.	Rs. 4,650
	Rs. 55,000·00

APPENDIX 37.2 (contd.)

(b) Return

(i) sale of fish after taking out pit, glands @Rs. 3/- per kg.	Rs. 4,800
(ii) sale of 5·0 m fry at Rs.120 per 1000 .	Rs. 60,000
	Rs. 64,800·00
	or Rs. 65,000·00
(c) Difference between return and cost. . . .	Rs. 10,000

(C) By providing additional pond, say of 0·5 ha, for raising common carp and artificially breeding them (without hypophysation) during the rest of the year, utilising the nursery capacity and other facilities created at the farm, extra quantity of 2·5 m fry could be produced by rearing 800 kg of broodfish.

(i) annual repayment of capital investment of Rs. 20,000 for providing 0·5 ha pond	Rs. 2,000
(ii) average annual interest	Rs. 1,000
(iii) cost of raising broodfish	Rs. 1,600
(iv) annual expenditure on recurring item . .	Rs. 3,000
(v) cost of nursing 5·0 m spawn to 2·5 m fry .	Rs. 1,250
(vi) water charges, repairs etc.	Rs. 2,000
	Rs. 10,850
	say Rs. 11,000
(vii) sale of 2·5 m fry of common carp @Rs. 10 per 1000 fry.	Rs. 25,000

Difference : Rs. 25,000—Rs. 11,000=Rs. 14,000.

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APPENDIX 37.3

(Paragraph 37.7.40)

Economics of Carp Culture

Item	Major carp culture (without manures, fertilisers and supplemental feeds) (Rs.)	Major carp culture (with manures and fertilisers but no supplemental feeds) (Rs.)	Composite culture of major carps and exotic carps with manures, fertilisers and supplemental feeds (Rs.)
	A	B	C
I. Cost functions :			
(a) Inputs :			
(i) stocking fingerlings@ Rs.100 per thousand	100·00 (1000 nos.)	200·00 (2,000 nos.)	250·00* (2000 nos)
(ii) manures Cattle dung @Rs. 15 per ton	..	150·00 (10 tons)	120·00 (8 tonnes)
chemical fertilisers : 100 kg urea; 100 kg Ammonia Sulphate; 200 kg Triple Superphosphate	..	275·00	275·00
(iii) Supplemental feeding 500 kg groundnut or mustard oil cake @Rs.0·90/kg	..	..	450·00
600 kg of rice or wheat bran @Rs. 0·50/kg	..	..	300·00
cost of inputs	=100·00	=625·00	=1395·00
(b) Netting :			
(i) depreciation charge on the nylon net costing Rs. 200 with durability for two years	100·00	100·00	100·03
(ii) labour charges	120·00 =220·00	120·00 =220.00	120·00 =220·00

APPENDIX 37 .3 (contd.)

	A	B	C
(c) Cost of capital loan and working capital			
(i) yearly instalment of loan @Rs. 5000 repayable in 10 equal instalments .	500·00	500·00	500·00
(ii) average yearly interest @10% per annum	275·00	275·00	275·00
(iii) Interest on the working capital @10% (cost of inputs + Rs. 200 for net and labour charges)	42·00	94·50	171·50
	=817·00	=869·50	=946·50
(d) Charges on account of water supply	425·00	425·00	425·00
(e) Miscellaneous repairs, maintenance etc.	200·00	200·00	200·00
	=625·00	=625·00	=625·00
total cost .	=1762·00	=2339·50	=3186·50
total cost (rounded) .	=1775·00	=2350·00	=3200·00
II. Return functions :			
(i) sale of fish @Rs. 3 per kg.	1200·00 (400 kg)	3600·00 (1200 kg)	6000·00 (2000 kg)
(ii) deduction due to commission on sale 5%	60·00	180·00	300·00
Net receipts	=1140·00	=3420·00	=5700·00
III. Profit or loss :			
(net receipts—total cost).	1140·00 —1775·00	3420·00 —2350·00	5700·00 —3200·00
	(—)635·00	(+)1070·00	(+)2500·00

*Rs. 50 more than in col. B because of higher cost of seed of silver carp and grass carps.

APPENDIX 37.4

(Paragraph 37.8.13)

Economics of Mulletculture in a Brackishwater Pond (Area 0·4 ha)

I. Cost functions :	
(a) Inputs :	
(i) stocking fry @Rs. 25 per thousand	Rs. 150·00 (6000 nos.)
(ii) chemical fertilisers	Rs. 275·00
(iii) artificial feeds	Rs. 500·00
	=Rs. 925·00
(b) Netting :	
(i) depreciation charge on the nylon net costing Rs. 200 with durability for 2 years	Rs. 100·00
(ii) labour charges	Rs. 120·00
	=Rs. 220·00
(c) Cost of capital working capitals :	
(i) yearly instalment of loan of Rs. 5,000 repayable in 10 equal instalments	Rs. 500·00
(ii) average yearly interest	Rs. 275·00
(iii) interest on working capital	Rs. 125·00
	=Rs. 900·00
(d) Miscellaneous, repairs, maintenance, etc.	Rs. 200·00
	=Rs. 200·00
total cost	=Rs. 2,245·00
total cost (rounded)	=Rs. 2,250·00
II. Return functions :	
(i) sale of fish @Rs. 3 per kg.	3,600·00 (1200 kg)
(ii) deduction due to commission on sale @5%	Rs. 180·00
net receipts	Rs. 3,420·00
III. Profit or loss (Net receipts—total cost)	Rs. 3,420·00 —2,250·00
	= +Rs. 1,170·00

APPENDIX 37·5

(Paragraph 37·8·15)

Eocnomics of Coconut Cultivation on the Embankment around Brackishwater Pond (0.4 had)

	Economics of one coconut palm										
	Age (yrs.)	Cost of cultivation Rs.	Interest Rs.	Harvesting charges	Total	Progressive total	Realisation from sale	Amount allowed for household expenditure	Loan repayment	Liability	Income from 46 palms (col. 8 × 46)
Non-fruition period	1	16·00	..	..	16·00	16·00	..	..	..	16·00	..
	2	4·00	1·60	..	5·60	21·00	..	..	..	21·60	..
	3	4·75	2·16	..	6·91	28·51	..	..	..	28·51	..
	4	6·25	2·85	..	9·10	37·61	..	..	..	37·61	..
	5	6·25	3·76	..	10·01	47·62	..	..	..	47·62	..
partial fruition period .	6	6·25	4·76	0·10	11·11	58·73	2·50	2·50	..	58·73	115·00
	7	6·25	5·87	0·40	12·52	71·25	10·00	3·75	..	71·25	172·50
	8	6·25	7·13	0·60	7·73	78·98	15·00	3·75	5·00	73·98	175·50
	9	6·25	7·40	0·80	9·20	82·18	20·00	5·00	8·75	73·43	230·00
	10	6·25	7·34	1·00	8·34	81·77	25·00	5·00	13·75	58·02	230·00
	11	6·25	6·80	1·50	7·30	75·32	37·50	5·00	26·55	49·07	230·00
	12	6·25	4·91	1·50	6·41	55·48	37·50	5·00	26·75	22·82	230·00
	13	6·25	2·28	1·50	3·78	26·60	37·50	4·65	26·60	..	213·90
	14th year onwards	6·25	..	1·50	7·75	..	37·50	29·75	..	..	1368·50

38

MARINE FISHERIES

1 INTRODUCTION

38.1.1 Sea fishing has been an occupation with the coastal people of India from time immemorial forming an integral part of the country's maritime heritage. Fishing operations have, however, largely remained near the shores venturing out into the open sea only a few kilometres from the base up to distances which could easily be covered by sailing craft. The occupation of fishing in general, was considered low in society and this, coupled with the prohibition of travel on the sea, commonly referred as *Kala Pani,* prevented the induction into it of capital and organisation from more resourceful communities. As such, the industry was developed solely by the traditional community of fishermen for centuries. Prior to Independence, fisheries, which in the maritime States had reached considerable proportions, was viewed principally as a source of revenue, and barring notable exceptions like the erstwhile Madras Province, hardly received any encouragement from the Government towards its development. Considering the circumstances under which the community of marine fishermen had evolved different techniques of fishing, built various types of craft and gear and successfully applied indigenous methods of preservation, it can be stated that the industry had reached a high degree of viability by the time of Independence. By comparison with the contemporary status of marine fishing in industrially advanced maritime countries, however, India's progress was tardy. A meaningful move towards a modernised marine fishing industry was made with Independence, taking into account the vastness of its resources and the need to apply tools of research and mechanisation for its development.

38.1.2 The basic need for providing research support to the industry was fulfilled by establishing the Deep Sea Fishing Station at Bombay in 1946, the Central Marine Fisheries Research Institute (CMFRI) at Mandapam in 1947 and the Central Institute of Fisheries Technology (CIFT) at Cochin in 1957, each having respective field stations at selected centres along the coast. Impetus to development was given through the fisheries schemes in the five year plans, which included loans and subsidies for several activities, mainly channelised through the fishermen's cooperatives as a step towards socio-economic progress of fishing communities. To enlarge the scope of development, the industry started receiving credit facilities from financial institutions, during the Fourth Plan period. The salient feature of development comprised addition to the mechanised fishing fleet of the country which numbered nearly 12,000 by 1974. Mechanisation was achieved by converting the existing sailing craft wherever possible or by the introduction of new types of boats. Progressive use of cynthetic fibres was the next step forward followed by use of materials indigenously manufactured for fabrication of fishing gears, and the introduction of bottom-trawling as an addition to the commercial fishing methods. These steps were taken for improving and increasing the total fishing effort which enabled the increase in marine fish production from 0.58 million tonnes in 1950 to the highest production of 1.16 million tonnes in 1971 during the period 1950-72 with an average annual yield of a million tonnes. The facilities for imparting training, considered necessary for implementing the programme of mechanisation, were created. The Central Institute of Fisheries Operatives (CIFO) was established at Cochin in 1963 for giving organised institutional training to operatives at various levels of skills particularly required for manning the larger fishing vessels requiring registration under Merchant Shipping Act (1958). Twentyseven Fishermen's Training Centres in the maritime States were set up to equip marine fishermen with sufficient working knowledge of mechanisation so that they could operate the small mechanised fishing boats themselves. Correspondingly, the developments in the processing sector of the industry were mainly characterised by a marked advance in methods of preservation using ice for fish and the application of refrigeration, by progressively establishing the necessary ice and cold storage, freezing and frozen storage plants during the plan periods. These facilities were virtually non-existent in earlier years of the First Plan. By 1972, ice factories were working with daily production capacity of about 550 tonnes, freezing plants with daily capacity of about 135 tonnes, cold storages having total capacity of 3,250 tonnes and frozen storages with total capacity of 2,360 tonnes.

38.1.3 The trawling effort gained rapid momentum in a short period of 20 years or so, considering that it was an innovation to the Indian fishing industry. It was mainly due to the fact that the prawns, which have the highest demand in the international trade, constituted an important ingredient of the trawl catch. This had resulted in boosting up the total exports of Indian fishery products, increasing the foreign exchange earnings from Rs. 2.46 crores prior to the first

Plan period to Rs. 79.58 crores in 1973. Realising the growing importance of the export of fishery products, the Government of India had set up the Marine Products Export Promotion Council in 1961 which was re-organised as the Marine Products Export Development Authority in 1972 with considerable executive powers and autonomy of operation. The incentive which marine fishing industry has received from export trade has been far reaching. It has been the principal factor which has enabled its rapid development in recent times.

38.1.4 The progress so far attained during the post-Independence period, has raised the status of the industry by its recognition as a promising arena of economic growth. The apathy of the former years has been replaced by all round interest including the induction of capital and management not only from individuals but also from highly organised corporate sectors in other industries.

38.1.5 The developments in the industry have, however, been concentrated on the aspects pertaining to exploitation of stocks of inshore fisheries adjacent to the Indian coast. This initial phase of development is understandable because of greater attraction of economic profiitability in ventures of short range operations requiring fishing boats of only moderate capital investment. Even in this respect, the industry has advanced with inadequate support of certain basic facilities by way of fishery harbours and landing sites. This is, however, reflected in the failure to attain the maximum possible fishing periods for boats and in the quality of the fish landed. There may still be prospects of increasing production by exploiting some of the under-utilised stocks in inshore waters of some regions. But the exploitation in the inshore sector alone would progressively tend to become intensive exploitation of inshore stocks of fish which would eventually result in a stage when the catch would be levelled of. The developments in this sector leading to intensive exploitation have also to be rational to avoid over capitalisation at the production level; otherwise, it would mean too many fishing units, each making too little money. It has already been reported that some of the fishery stocks along some of the regions have nearly reached the sustainable production limits. Thus even the intensive exploitation of the inshore region would have its limitation of contributing to the total production. The intensive exploitation of inshore fisheries resources would also mean the partial utilisation of the entire marine resource available in the Indian seas for increasing production. In contrast, almost all the maritime countries have progressively undertaken integrated developments, extending their range of operations by employing larger fishing vessels including factory ships with sophisticated equipment for fish finding, fish catching and processing. Such a capital intensive programme has been supported by providing necessary infrastructure facilities and providing incentives to make a viable national marine fishing industry. This could be achieved mainly by identifying fish production with the food industry and developing the same as a nutritional service to the nation. Enlarging the base of marine fishery production in India would enable the industry to provide more nutritional food, more foreign exchange and more working opportunities for the people, particularly the fishermen at the production level and in the ancillary aspects of the industry.

2 PRODUCTION TRENDS

Estimates of Production

38.2.1 In countries where marine fishing industry is well organised, the catch and effort statistics are obtained by complete enumeration from the logs kept by the skippers of fishing vessels. The nature of the industry in India, with a very large number of fishing units managed by illiterate fishermen landing fish all along the long coastline necessitated the working out of a suitable sampling design. The CMFRI, after undertaking a number of sample surveys, devised a sampling technique based on space-time stratification. The method has been tested and improved upon from time to time. Since 1950, the CMFRI has been furnishing estimates of marine fish production of India, separately for each maritime state, giving details of quarterly and annual catches and their constituent fishery composition. These estimates are adopted by the government for progressive evaluation and transmission of information required by the Food and Agriculture Organisation of the United Nations (FAO) for incorporation in the Yearbook of Fishery Statistics. Some of the States had employed their own surveys, furnishing separate estimates which had shown some variations from the CMFRI estimates. The CMFRI has also reported that the sampling error of the estimate was about 5·7 per cent at the all-India level. The question of this anomaly in the estimates has been dealt with in the Section on Fishery Statistics in the Chapter 61 on Statistics. A suggestion has been made in the Chapter to increase the sample size which should be done by integrating the surveys carried out by the States and the CMFRI and then working out a single estimate. The production figures in this Chapter pertaining to India and its maritime States are based on the estimates given by the CMFRI, and for those pertaining to regions outside India reference has been made to the FAO Yearbooks on Fisheries Statistics.

Production Growth

38.2.2 The production of any maritime country over a number of years, as a result of increasing fishing effort, has generally an upward trend so long as the composite fisheries are rationally exploited. But, it may sometimes happen that the production in some years may be less despite the increase in fishing efforts. This is mainly due to considerable yearly variability in the abundance of fish stocks due to natural causes. It has been a common experience that such natural fluctuations are of considerable magnitude in the pelagic fisheries of small shoaling fishes such as sardines, mackerel, anchovies, herring etc. whose populations are seriously affected by oceanographic changes.

38.2.3 The world marine fish production had increased from 15·4 million tonnes in 1950 to the highest figure of 60·9 million tonnes in 1970 during the period 1950-73, indicating an annual increase of about 15 per cent. The development of long distant water fishing fleets by some advanced maritime countries, and the development of large scale local modern fisheries from bases adjacent to the fishing grounds in countries throughout the world contributed to this growth rate. In these developments, the largest share has been the catching of clupeiod fishes and other large volume low-priced species of fishes used mainly for fishmeal industry. It may be of interest to note from the following figures, how in Peru a single species of anchovy for fishmeal manufacture has contributed to the world production of marine fish and how its decreased production in 1972 and 1973 affected world production.

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(million tonnes)

	1950	1960	1968	1969	1970	1971	1972	1973
catch of Peru (mainly anchovy)	0·074	3·7	10·6	9·2	12·6	10·6	4·8	2·3
world marine fish production	15·4	29·1	55·9	54·3	60·9	60·6	55·8	55·9

38.2.4 The marine fish catch from the Indian ocean by all countries increased from 1·9 to 2·5 million tonnes during 1964 to 1972, indicating an annual growth rate of about 4 per cent. The catch of India accounts for about 40 per cent of Indian ocean fish production. The marine fishery production of India increased from 0·58 million tonnes in 1950 to 1·16 million tonnes in 1971, with an average annual growth rate of about 5 per cent.

38.2.5 To have an idea of the production of maritime States, annual percentage growth rate of the average of quinquennium ending 1972 over 1951 is given in Table 38·1. Besides, percentage contribution of each State to all-India production, on the basis of aggregate average of ten years (1963-72) is also indicated therein.

TABLE 38.1

Annual Growth Rate in Production in Maritime States and Their Percentage Contribution to all-India Production

Maritime States	Annual growth rate: percentage increase (average of the quinquennium ending 1972 over 1951)	Percentage contribution to all-India production
west coast		
Kerala	4·1	36·4
Maharashtra	5·1	17·1
Gujarat	4·3	9·2
Karnataka	2·1	8·6
Goa	..	2·1
Lakshadweep	..	0·1
		73·5
east coast		
Tamil Nadu and Pondicherry	5·4	16·1
Andhra Pradesh	1·6	8·3
West Bengal and Orissa	17·1	2·0
Andaman & Nicobar Islands	..	0·1
		26·5

38.2.6 It has been observed that there were considerable variations in the magnitude of production of marine fish during the period 1951-72. The average all-India production during the quinquennium ending 1972, however, showed an increase of 4·1 per cent. per annum as compared to 1951. West Bengal-Orissa had the highest growth rate of 17·1 per cent per annum followed by Tamil Nadu-Pondicherry (5·4 per cent), Maharashtra (5·1), Gujarat (4·3), Kerala (4·1), Karnataka (2·1) and Andhra Pradesh (1·6) as compared to the year 1951. It may also be seen that the contribution of the States on the west coast to all-India was 73·5 per cent. whereas in respect of the States on the east coast, it was only 26·5 per cent. Kerala recorded the highest contribution of 36·4 per cent. followed by Maharashtra (17·1), Tamil Nadu (16·1), Gujarat (9·2), Karnataka (8·6) and Andhra Pradesh (8·3).

Production by Constituent Fisheries

38.2.7 The marine fisheries in the tropical and sub-tropical waters of the world are generally characterised by greater diversity of species than in the temperate zones. This phenomenon, in the totality of the trophic levels in ecosystem, results in forming comparatively less abundance of each species. This fundamental difference between temperate and tropical fisheries is reflected, not only in the complexity of giving a wider cover of research and investigation in understanding and managing the constituent fisheries of diverse species but also in their exploitation phase and in the aspects of economics of production.

38.2.8 The marine fisheries of India are characterised by the presence of a large number of species. For determining the trends in production in the constituent fisheries, the CMFRI has classified them into 37 groups, each containing one or more species. Quantitatively, the relative importance of the 37 groups taking average of the landings during the period 1963-72, will be evident from figures given in Appendix 38.1. The production characteristics of only some of the constituent fisheries, important from the point of view of either quantity or quality, are given below.

38.2.9 Oil Sardine : Taking into account the quantity of catches, the oil sardine, *Sardinella longiceps* Val. is the most important marine fish, contributing 23-24 per cent of the total landings in India. This fishery is mainly exploited in the narrow coastal belt between Quilon (Kerala) and Ratnagiri (Maharashtra). Stray catches are, however, obtained in the inshore areas outside this geographical zone, particularly in the areas of abundance. The two States, Kerala (83 per cent) and Karnataka (16 per cent) contribute together nearly 99 per cent of the catch of this fish. The main fishing season lasts from August to April, the peak being October-December. The fishery is characterised by wide fluctuations in the annual catches; thus, during the period 1963-72 the catch varied between 63·6 (1963) and 301 thousand tonnes (1968). It has been reported that these fluctuations are largely due to factors other than fishing pressure. The catch is mainly supported by young individuals which are within the group of one year old fish. The fish is mainly caught by boat seines and gill[illegible] Kerala, and by shore-seines and gillnets in Karnataka. Where the oil sardine spawns, wherefrom it comes in the inshore waters to constitute this fishery and where it goes after the fishing season are little known.

38.2.10 Mackerel : This fishery is mainly constituted by the Indian mackerel, *Rastrelliger kanagurta* Cuv. It occurs along both the coasts contributing 8·2 per cent to the total marine fish catch. The major fishery exists along the west coast, following nearly the same geographical pattern as in the case of oil sardine. The percentage contribution of different States to the mackerel catch is nearly 40·53 by Kerala, 15·86 by Karnataka, 14·61 by Goa, 7·35 by Maharashtra, 3·73 by Tamil Nadu, 2·75 by Andhra Pradesh and 1·15 by the remaining States and Union Territories. This fishery is, like oil sardine, subject to great annual fluctuations which are reported to be due to fishery independent factors. There appears to be some inverse relationship between abundance of this species and the oil sardine. The annual landings of mackerel during the period 1963-72 varied from 20·8 (1968) to 185 thousand tonnes (1971). The fishing season on the west coast lasts from September to April. Like oil sardine, this fishery is mainly supported by under-yearlings and yearlings. The fishery is exploited by the same types of gear as for oil sardine.

38.2.11 Bombay duck : The Bombay duck, *Harpodon nehereus* (Ham.) contributes on an average 8·3 per cent to the total catch. It constitutes a major fishery along the north-west coast with Maharashtra (35·3 per cent) and Gujarat (62·8 per cent) together contributing as much 98·0 per cent of the catch of this fish, whereas along the east coast it forms only a minor fishery, with West Bengal, Orissa and Andhra Pradesh together contributing only 2 per cent. The fish is mainly caught in the stake bag nets (*dol*) during September to February. The fluctuations in the annual catches are not very large. Due to mechanisation of fishing craft and improvements in the gear, the landings of this fish exceeded 100,000 tonnes per annum by 1960. Since then, the catches have remained within the range of 70,000-90,000 tonnes per annum, indicating that developments which had taken place in the fishery were not commensurate with the increase in the catch of this fish. In fact, there have been indications of decrease in the catch per unit effort as well as decline in the average size of fish. The greater part of the catch is sun-dried on specially erected bamboo scaffoldings.

38.2.12 Other Sardines : The fishery of other sardines or lesser sardines, consists mainly of four species, *Sardinella fimbriata* (Val.), *S. albella* (Cuv. and Val.) *S. gibbosa* (Blkr.) and *S. Sirm* (Rup). Except for the last mentioned species, which has very limited distribution in the extreme southern zone of peninsular India, the others contribute to localised fisheries which often overlap one another in their areas of abundance. The average catch of lesser sardines is of the order of 46,000 tonnes per annum contributing about 5·0 per cent to the total marine fish catch. Sizeable landings take place in Tamil Nadu, Andhra Pradesh and Kerala, the respective percentages being 33·5, 29·4 and

22·6 respectively of the total catch of these fish, whereas the percentage contributions by West Bengal and Orissa, Karnataka, Maharashtra, Goa and Pondicherry are 5·1, 3·3, 3·2, 1·4 and 1·3 respectively. The fishery is exploited in the coastal region by operating shore seines, boat seines, gillnets and cast nets in different regions, and the catch mainly consists of 0-year classes.

38.2.13 Elasmobranchs : The elasmobranchs, comprising several species of sharks, skates and rays, constitute an important group of large sized fishes occurring all along the coastline of India; their average annual production is about 37,000 tonnes, forming 4·1 per cent. of the total marine fish landings. The sharks are mainly caught on hook and lines and in drift gillnets, whereas skates and rays are caught mostly in the trawls and bottom-set gillnets. Apart from their use as food, they yield liver oils with high vitamin A content. The dried shark fins are used for preparing soups and form an item of export.

38.2.14 Leiognathus (Silver Bellies) : The fishery of silver bellies, comprising several species of *Leiognathus*, is confined to the coastal belt, with greater abundance along the coastline of Andhra Pradesh, Tamil Nadu and Kerala. The catches in other States are comparatively insignificant. The fish are caught in shore seines and boat seines. But a good proportion of them in the trawl catch has brought about an increase in their landings in recent years. The average catch for ten years (1963-72) comprised 35,000 tonnes forming 3·8 per cent. of the total marine fish catch. The catch is mainly composed of juveniles. Only a small part of the catch is consumed fresh, and the rest is dried. The silver bellies also form the raw material for the manufacture of fishmeal of high quality.

38.2.15 Ribbon fishes: The fishery is constituted by 4 species, of which *Trichiurus lepturus* Linn. is the most predominent in the catches. These fishes contribute about 32,500 tonnes or 3·6 per cent. of the total catch. Nearly 40 per cent of the catch of these fish is landed in Tamil Nadu, whereas Kerala, Andhra Pradesh and Maharashtra contribute 22, 16 and 14 per cent. respectively. The season for the fishery, in different States varies considerably, but generally extends from July to March. The most common types of gear operated for these fish are shore-seines and stake bag nets. Ribbon-fishes, although consumed in the fresh condition to a certain extent, are mostly cured with salt or sun-dried.

38.2.16 Sciaenids : The fishery of sciaenids consists of both, larger forms mainly represented by two very important commercial species, *koth, Otolithoides brunneus* (Day) *and ghol, pseudosciaena diacenthus* (Lac.), and a large number of small low-priced lesser sciaenids. Although the sciaenids form a fishery all along the coastline of India, the catches of *ghol* and *koth* support a sizeable fishery mainly off

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the Maharashtra and Gujarat coasts. The catch of sciaenids comprises an average of about 30,000 tonnes per annum, contributing 3·3 per cent. of the total catch. A good part of the trawler landings consists of sciaenids. The air bladders of *ghol* and *koth* constitute an important by-product. They are sun-dried and exported for the manufacture of isinglass.

38.2.17 Catfishes: Catfishes include a large number of commercial species. They are abundant all along the Indian coast. Their landings are highest in Kerala, Maharashtra, Tamil Nadu, Gujarat, Andhra Pradesh, Karnataka, and West Bengal and Orissa follow in the order of decreasing abundance. The catch of catfishes is about 30,000 tonnes per annum, contributing 3·3 per cent. of the total marine fish landings in the country. They are caught in all types of gear, particularly hook and lines, and are consumed in fresh or cured condition. The air bladders are dried and used for the manufacture of isinglass.

38.2.18 Pomfrets: Pomfrets are considered the best among the table fishes. The fishery consists of three species, of which two, namely silver pomfret, *Pampus argentus* (Euphr.) and white pomfret *P. chinensis* (Euphr.) are systematically related, whereas the third, brown pomfret-*Parastromateus niger* (Bl.) is not a true pomfret but is merely grouped with them because of similar shape. The silver pomfret has the highest demand. The catch of pomfrets had averaged about 21,000 tonnes per annum during the period 1963-72, contributing 2·3 per cent. of the total marine catch. They are caught from all along the east and west coasts, but the landings in Gujarat and Maharashtra account for the bulk of the catch of these fishes. Generally pomfrets are available throughout the year, but their periods of peak landings vary from place to place. In the northern parts of the east and west coasts, heavy landings occur during November to February, whereas in the southern parts of the peninsula they become plentiful during the monsoon and post-monsoon months. Drift gillnets form the major commercial gear to catch these fishes. They are also caught in the bag nets and trawlnets. Considerable quantities of juvenile are caught in stake bag nets, which constitute a destructive gear for pomfrets.

38.2.19 Seerfishes: Seerfishes are also highly esteemed table fishes. The fishery is mainly constituted of three species: *Scomberomorous commerson* Lac., *S. lineolatus* (Cuv.), and *S. guttatus* (Sch.) All the three species are found in varying quantities along both the coasts of India. The all-India annual average catch for the period 1963-72 was 12,700 tonnes forming 1·4 per cent. of the marine fish catch. The major catch comes from Tamil Nadu, Andhra Pradesh and Kerala, although fair quantities are also landed in Maharashtra and Karnataka. In Tamil Nadu, the fishing starts in March and terminates in October.

In Andhra Pradesh, the fishing generally lasts from February to May. On the west coast of India, the season is from October to May with peak during November-December. Seerfishes are caught in types of gear used for other fishes, but a high proportion of landings is made by gillnets and hook and lines.

38.2.20 Perches: The fishery is constituted by numerous species on both the east and west coasts, and is particularly rich around the coral reefs and rocky bottoms of the sea, in the inshore and offshore waters. The grounds in the region of 70-130 m depth off Kerala have been discovered to be very rich in the rock-cods or *kalava, Epinephalus* spp. but the resources have not yet been exploited. The present exploitation of perches yield a catch of 11,300 tonnes per annum, contributing 1·1 per cent to the total catch. The fishes are caught by hook and lines, gillnets and baited basket-traps.

38.2.21 Polynemids: The fishery of polynemids or threadfins, known by 9 species, occurs in all the coastal waters of India. Of these, two species, *Eleutheronema tetradactylus* (Shaw) or *rawas* and *Polynemus Indicus* (Shaw) or *dara* are large sized and greatly esteemed table fishes. They constitute the most important species of the polynemid fishery off Maharashtra and Gujarat contributing nearly 80 per cent to the polynemid catch of 4,300 tonnes in the country. *Dara* is the major species supporting the fishery in this region. The catch of all the polynemids averages about 4,300 tonnes per annum contributing only 0·5 per cent of the total catch. They are caught in all types of gear as an incidental catch. In Maharashtra and Gujarat, they are caught in stake bag nets, bottom-set long lines, and bottom drift gillnet. Of these, the last one is a specialised gear employed almost exclusively for large sized *dara* during December-May including during its breeding season which is reported to be April to June. It has been considered that the fall in the catches of this most important species of polynemid seems to be due to the baneful effects of this gear.

38.2.22 Tunnies and Skipjack: This group includes tuna, tunnies or lesser tuna, sailfishes and sword fishes which are economically important fishes. There is no organised fishery from the coast of the mainland of India; these fish form only incidental catch in the operations for other fisheries. The frigate mackerel *Auxis thazard* (Lac), the oriental bonito *Sarda orientalis* (Tim. Schl.), the little tunny *Euthynnus affinis affinis* (Cantor) and the northern blue fin tuna *Thunnus (Kishnoella) tongol* (Blkr.), are the main species caught in the coastal waters. There is, however, an organised fishery of small magnitude for oceanic skipjack *Katsuwonus pelamis* (Linn.) from the Lakshadweep group of islands. This fish is caught by pole and line method which in the recent years is being operated progressively from mechanised boats. The average catch of all types of tuna and tuna like fishes is about

4,000 tonnes per annum. Although India's catch of these fishes is negligible at present, her position in the Indian ocean offers considerable advantage for the development of high seas fishing for oceanic tuna as given in Section 5.

38.2.23 Other fisheries: The percentage contribution of most of the remaining constituent fisheries is less than one per cent each. These together constitute a group of miscellaneous catch contributing nearly 3·0 per cent of the total landing. However, as a result of enlarged operations of mechanised boats, new fisheries of small magnitude, but of significant quantities in their total, have been formed and now enter the markets. Of these, the fishery of the threadfin breams or nemipterids (*killimeen*), occuring all along the coast of India and particularly in the deeper waters off Kerala, has been yielding increasing quantities of catches.

3 RESOURCE POTENTIAL, SURVEY AND ASSESSMENT

Resource Potential

38.3.1 In the oceans, as on land, primary organic production starts with photosynthesis. Except for small quantities of large seaweeds directly utilised by man, the marine plant life mostly consists of microscopic organisms or phytoplankton, which are grazed upon, directly or indirectly, by all marine animals, followed by a food chain in a sequence of different trophic levels. The potential fishery productivity is the harvest that is taken by man on a continuing basis from the apex of the trophic pyramid of harvestible organisms. Thus the fishery productivity is basically related to two important factors, photosynthesis and the nutrients in sea water. This relationship gives the corresponding land features of 'pastures' and 'deserts' in the oceans. Production of phytoplankton is naturally highest where the maximum amount of nutrients and sunlight are available. These are quickly used up by animal plankton. Both types of plankton attract many other organisms and fishes.

38.3.2 In certain areas of the oceans the surface waters are continually replenished by the upwelling of the colder and nutrient laden waters from below. Such areas are the sources of some of the world's best fisheries. Colder waters, where summer and winter alternate, have a natural vertical circulation and seasonal replenishment of surface nutrients. In general, the temperate waters are better endowed with fisheries. In the tropical waters there is a lower standing crop but to some extent this is compensated by more rapid growth and organic turnover. Diagnosis of areas of upwelling in tropical waters thus assumes special importance in locating fisheries. The greatest intensity of upwelling takes place at the divergence of opposite moving water masses or in proximity to land subject to strong offshore winds. Nutrient replenishment also takes place in the shallow seas, areas where there is runoff from the land and the regions where massive overturn between cold waters of high latitude and warmer waters of lower latitude takes place.

38.3.3 The food chain for many small floating pelagic species such as sardines, mackerel, anchovies and herrings, which are to a great extent plankton dependent fisheries, is a short one; they can maintain large populations in the upwelling zones yielding very rich pelagic fisheries. The sea adjoining the south west coast of India is one of the important upwelling areas of the Indian ocean, yielding productive pelagic fisheries, particularly of sardines and mackerel.

38.3.4 Some fishery scientists of the world have projected various estimates of the potential of the fishery harvest of the three oceans. Most of these estimates vary within the range of 120 to 200 million tonnes per annum, thereby indicating that the present production of about 60·0 million tonnes could be increased by a factor reckoned between 2 and 3. It can be seen from the following figures that the Indian ocean is the least exploited of the three oceans.

Name of ocean	Catch in 1972 (million tonnes)	Total surface area (million sq km)	Catch/ sq km (tonnes)	Continental self area (million sq km)	Catch/ sq km (tonnes)
Indian . .	2·50	74·917	0·033	2·80	0·893
Atlantic . .	23·32	106·463	0·219	9·65	2·696
Pacific . .	33·53	179·697	0·186	8·41	3·987

38.3.5 In developing the marine fisheries and increasing production from the Atlantic and Pacific oceans, the estimates of potential fishery yields have served as useful indices in determining the expansion scope during different phases of planning. It has been reported that these indices have tended to err on the conservative side as the estimates formulated have been exceeded during different phases. The potential fishery yield of the Indian ocean has been estimated by different authors, either on the basis of extrapolating the catch of the Atlantic and Pacific oceans or on the primary production and subsequent transfer of energy to various levels. These estimates[1] have indicated that the present catch of about 2.5 million tonnes could be increased by a factor of 3, 4 or even 8. Although the estimates may vary, there is a definite indication that the present yield from the Indian ocean could be substantially increased. Even a conservative estimate of the Indian ocean yield places the potential output at 14 million tonnes per annum.

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[1] (i) Panikkar. N.K. 1967. Fisheries resources of the Indian Ocean. NISI/INCOR Symposium on Indian Ocean. Bull. nat. Inst., Sc. Ind..38(2) : 811-832.

(ii) Marr, John C. *et al.* 1971. A plan for fisheries development in the Indian Ocean. FAO.—IOFC/Dev/71/1.

(iii) Pasad R. R.. 1970. A quantitative assessment of the potential of fishery resources of theIndian Ocean and adjoining seas. Ind..Janim.Sci.,40(1) : 73-98.

38.3.6 It is wellknown that nearly 90 per cent of the world catch comes from waters over the continental shelf i.e. the region up to about 200 in depth, occupying only 7.6 per cent of the total area of the oceans. As such, the fishery potential of the continental shelf of India would be of primary significance. It has been estimated by various Indian fishery scientists that the shelf has a potential of 2.4 million tonnes comprising 0.7 million tonnes from demersal fisheries and 1.7 million tonnes from pelagic fisheries. The Statewise information on the particulars of continental shelf and potential yields is given in Appendix 38.2. The extensive resources beyond the continental shelf hold additional potential for increasing production from conventional and non-conventional types of fisheries, comprising high seas tuna, deep sea fishes, oceanic cephalopods particularly squids and deep sea crustaceans. Besides, there is considerable potential for increasing production from the under-exploited molluscan resources in the continental shelf, particularly the oysters, mussels and clams. Considering all these potentials, we feel that the production of marine fish, excluding mariculture, should be increased from the present average of about 1.0 million tonnes per annum to at least 3.5 million tonnes per annum after 25 years.

Resources Survey and Assessment

38.3.7 Fishing areas, which are being commercially exploited by the marine fishermen of India with the fishing methods developed by them, mostly comprise the coastal regions. The expansion of the industry for increased production necessitated developments in the harvesting effort by introducing new fishing methods and by improving the present ones for exploiting the under-utilised stocks in the traditional regions and for exploiting the new grounds beyond. It is known that the fishing areas all the world over, apart from those which are intensively exploited in the coastal regions, are generally confined to relatively limited areas of the continental shelf and beyond. To find out areas of commercially exploitable fish stocks, their distribution and densities and make an assessment for eventually utilising such areas for economic use would involve a complex series of invesitgations involving the survey and assessment of fisheries resources.

38.3.8 Present status in India: Several surveys, with main emphasis on exploiting suitable grounds for undertaking ground or demersal trawling, were undertaken during the period 1900-1945 by the then Provincial Governments as *ad hoc* schemes. These efforts, however, did not result in any commercial exploitation. It was only subsequent to 1946 that purposeful exploratory efforts were undertaken by different agencies beginning with the establishment of the Deep Sea Fishing Station at Bombay by the Government of India. This led to the commercial adoption of bottom trawling in the area between Bombay and Kathiawar. Then followed the Indo-Norweigian Project in Kerala, expanded activities of the Deep Sea Fishing Station at other centres and exploratory surveys by some of the State Governments during the fifties. Operation of trawls from small mechanised fishing boats has progressively increased in number since 1950. This had a marked significance in the history of marine fishing industry of India as this method was responsible for making a large scale contribution to the total catch of exportable quality of prawns in recent years.

38.3.9 There are at present three agencies—Deep Sea Fishing Organisation (DSFO), the Integrated Fisheries Project (IFP) and the United Nations Development Programme (UNDP) Pelagic Fisheries Project, which are engaged in the resources survey work under the Department of Agriculture, Government of India.

38.3.10 Deep sea fishing organisation : The fisheries survey is mainly conducted by the DSFO which was established in 1946 with the following objectives, initially with Bombay as the first station:—

(i) to carry out work for the purpose of (a) charting of fishing grounds; (b) determination of the types of fish available; (c) examination of the types of gear available; (d) assessment of suitability of different types of fishing vessels ; and (e) assessment of suitability of different types of fishing gear and equipment, especially nets ;

(ii) to train personnel for fishing operations on modern lines; and

(iii) test the commercial possibilities of deep sea fishing and making available the requisite data and information to those concerned so as to help and guide the expansion of fishing industry.

38.3.11 To extend the coverage of survey work, three bases one each at Cochin, Tuticorin and Visakhapatnam and two bases one each at Mangalore and Veraval, were started during the Second and Third Plan periods respectively. The stations at Mangalore and Veraval had to be closed down and the proposals to open new stations at Port Blair in Andamans and Paradeep in Orissa during the Third Plan period did not fructify. This happened because, in spite of Plan provision, the government did not give this sector a high priority for release of foreign exchange. It could not also make any new investment on vessels for several years and often depended purely on assistance from aid-giving agencies. It was only after 1972 that seven more bases one each at

Kandla, Goa, Mangalore, Madras, Paradeep, Calcutta and Port Blair were established. With further establishment of one more station at Veraval in the near future, the DSFO will have a full complex of 12 bases, six on the west coast and six on the east coast but all are poorly supplied with dependable vessels. The DSFO has a fishing fleet of 30 vessels, 20 of 17.4 m length, and five in each of the two groups below and above this size. The exploratory work has been mainly conducted from Bombay, Cochin, Tuticorin and Visakhapatnam. From the performance of the vessels engaged in the exploratory work, it seems that all the vessels could go out only to the extent of about 30 per cent of the expected number of days in a year at sea. The inadequate utilisation of the vessels has been due to delays in loading and unloading at fishing ports, repairs and servicing of vessels, delay in the examination and certification of fishing vessels by the Mercantile Marine Department etc. The DSFO had covered only about 48,000 sq km, comprising 26,000 sq km on the west coast and 22,000 sq km on the east coast, mainly within the depth of 60 m, out of the total area of about 415,000 sq km of the continental shelf. There is a proposal to augment the fishing fleet of the DSFO with about 8 vessels in the range of 20 to 30 m to be constructed locally with foreign assistance.

38.3.12 Information on demersal trawl grounds, chartered so far as a result of survey undertaken by the DSFO during the last 28 years, was not brought out in the form of any periodical reports on the evaluation of the progress. The information was mainly compiled on the comparative suitability of fishing grounds in relation to quality and quantity of catches and was published in the form of scientific papers in various journals. Considerable data so far collected have not been put to any economic assessment for preparation of feasibility reports and the commercial possibilities of exploiting the fishing grounds found suitable as a result of survey work.

38.3.13 As the survey work conducted by the DSFO did not make satisfactory progress, the Ministry of Agriculture and Irrigation set up, subsequent to 1970, a Central Advisory Committee on Exploratory Survey of Marine Fisheries, which would meet twice a year to formulate survey programmes, to evaluate the results of survey and to improve dissemination of information as would be useful to the industry. Wherever the organisation established bases, a sub-committee was set up for each sub-station to review the work and to suggest necessary measures for improving the efficiency.

38.3.14 The survey work so far conducted by the DSFO has, however, indicated that the most productive trawling grounds are in the north west coast of India, bordering Gujarat and Maharashtra States, upto about 75 m depth, particularly in the Bombay-Kutch region not only for quantity yield but also for quality fish comprising *ghol, dara, koth, karkara* etc., constituting a fair percentage of the catch. It can be seen from the Appendix 38.2 that the continental shelf of Gujarat and Maharashtra has a ground area of about 204,000 sq. km out of the total area of 415,000 sq. km for the whole country. It has also been estimated that this area has a potential of yielding an additional 400,000 tonnes from demersal fisheries. Besides, there is already a proven feasibility of commercially exploiting this region, as it was being already exploited during the period 1956-73 by an Indian company in collaboration with a Japanese firm; subsequently the interest of the company was diverted to trawling grounds for catching prawns for export. It has been observed that the interest of the industry in undertaking bottom trawling is, at present, mainly oriented towards prawns as the main commodity. The situation that even the proven grounds are not being put to economic utilisation point to the need for a public sector organisation to give a lead to the industry.

38.3.15 Integrated fisheries project : The work of the Indo-Norwegian Project (INP) was principally done in the south-western region of the coast with reference to small boat trawling and the evolution of suitable craft, fishing techniques and attendant processing and marketing methods in the Kerala area. The administration of the INP, established in 1952, was taken over by the Government of India and was renamed as Integrated Fisheries Project (IFP). The INP in the first ten years did a commendable area development work near Quilon in Kerala, in assisting the fishermen to increase their returns from fishing, to improve fish handling, processing and distribution and to improve their health and sanitary conditions. After completing this area developmental work, the project had shifted to Cochin from where it pursued a developmental programme of integrated fishery complex. For this purpose, it developed the facilities comprising slipway and workshop, ice plant-cum-processing and freezing plant, gear design, repairs and maintenance section, electronic repairs and maintenance laboratory, design and development cell, experimental and exploratory fishing, training, marketing etc. The project laid considerable emphasis on exploratory and experimental fishing. The IFP has at present, a fishing fleet of 14 vessels out of which seven are about 17 m in length and above and the remaining ones are smaller.

38.3.16 The INP carried out systematic exploratory fishing with larger vessels along the south-west coast of India, in the deeper waters of the continental shelf and the upper continental slope, between 75-450 m. In the depth zone of 75-100 m between Mangalore and Quilon, the survey indicated that there were numerous outcrops of rocks harbouring good quantities of the perches (*kalva*) and the rock cod (*velameen*), yielding as much as 75-440 kg/ha per 100 hooks in experimental line fishing. Inter-spersed between the rocky patches were moderately productive trawling grounds for lesser or unpopular varieties of fish. In the deeper zone of 100-180 m, fairly productive trawling grounds were discovered, also yielding lesser varieties of fish and large quantities of a deep water crab. In the last zone, between 180 and 480 m, there was an abundance of bathypelagic fishes and larger species of sharks. The most revealing feature of this zone was the existence of fairly rich grounds of deep sea prawns and lobsters, particularly in the area lying southwest of Quilon. A similar rich fishery of deep sea prawns and lobsters was also discovered in deep waters off the southeast coast of Tamil Nadu. Although a few subsequent trials of experimental fishing have been conducted by IFP, there has hardly been any fishing effort developed for commercial exploitation. Another important finding during the exploratory studies jointly undertaken by INP and CMFRI, was the abundance of oceanic squids, particularly *Symplectoteuthis oualaniensis*, which is being exploited as a commercial fishery in the Pacific ocean.

38.3.17 Pelagic fisheries investigation project : It has long been felt that the pelagic fishery resources of oil-sardine and mackerel along the southwest coast of India were capable of yielding increased production. The aforementioned UNDP (Special Fund) project, undertaken through FAO in cooperation with the Government of India has been in operation in Cochin since 1971, with the main objective of assessing the abundance of the stocks of oil-sardine and mackerel, determining their distribution in time and space, studying their life histories and conducting fishing experiments for finding out suitable fishing methods. The Project, with necessary supporting scientific staff, has been conducting resources survey, with the help of two research vessels, one 16.5 m and the other 46.3 m in length, equipped with sensitive hydroacoustic and other instruments. In the course of 4 years, the Project has formulated preliminary estimates of resources size of oil sardine and mackerel at 0.4 million and 0.45 million tonnes respectively, which are subject to confirmation by further assessment studies. These fishes were encountered in large numbers beyond the present zone of exploitation by the traditional craft, and were observed both before and after the usual fishing season of September to March. There are, therefore, good indications that commercial fishery for oil sardine and mackerel can be considerably extended. The Project, in the course of survey work, incidentally discovered, and then identified, the additional resources of white bait, *Anchoviella* spp. (*c.* 0.9 million tonnes), horse-mackerel (*c.* 0.13 million tonnes), and semi-pelagic fishes called 'shallow-water mix', constituted by *Caranx* *kalla,* silver bellies etc. (*c.* 0.13 million tonnes). The results of preliminary fishing trials undertaken from the vessels of IFP, particularly from smaller vessels of 9.7 m and 11.0 m in length by purse seining, gave very encouraging results. In the light of the resources survey and assessment of pelagic fisheries beyond the traditional zone of exploitation along the coast of Karnataka and Kerala already carried out, we feel that the strategy for exploiting this additional resource should be developed as early as possible. This would help in diversification of fishing effort from bottom trawling to purse seining and semi-pelagic trawling. It should, however, be seen that the exploitation of this fishery in the traditional zone by the existing fishing methods is not affected.

38.3.18 Potential of the Wadge Bank: The Wadge Bank, lying beyond the southern tip of peninsular India, has an area of about 13,500 sq km and has been well known to the fishermen of, Kerala and Tamil Nadu. A few exploratory surveys conducted by undertaking trawling, and by dory fishing with hook and lines, have proved the richness of this region for demersal fishes, particularly perches. The catches consist of certain resident fishes such as the snappers and migrants mostly the carangids, the latter reaching the bank during the period of southwest monsoon. From organic productivity studies, the potential fish production has been estimated at about 25,000 tonnes per annum. The present level of annual production by the trawlers of Sri Lanka is about 2,000 tonnes which is proposed to be stepped up in the coming years. The production by India from this bank is very small in relation to the potential yield. For increasing production from the fishery of the Wadge Bank, we recommend that the State Governments of Kerala and Tamil Nadu should formulate specific schemes for stepping up production, particularly by developing fishing effort by mechanised fishing boats from the bases at Tuticorin and Vizhinjam.

Role of Research Institutes

38.3.19 The CMFRI, Cochin and the CIFT also at Cochin, were established in 1947 and 1957 respectively by the Ministry of Agriculture and Irrigation; they came under the control of the Indian Council of Agricultural Research (ICAR) in 1967.

38.3.20 Central Marine Fisheries Research Institute: The Institute was established at Mandapam in 1947 and since then has developed into the foremost Indian centre for marine fisheries research in the country. The headquarters was shifted to Cochin in 1970. In addition to the headquarters, the Institute has one regional centre, nine substations, three research units and 26 survey units. The programme of research and survey work covers mainly the fields of (a) estimating marine fish production on an all India basis, specieswise, seasonwise, and statewise; (b) biological studies of commercial species of fish and their populations in relation to fisheries; (c) environmental studies in relation to fisheries; (d) exploring new grounds and untapped resources; and (e) mariculture. The Institute is geared to advise on the maximum sustainable yield from each type of fishery and suggest regulation of catches if that becomes necessary. Research work done at the Institute has so far centred mainly around the biologically-oriented problems. Even this field of research work had to be limited to the examination of research material obtained at different fish landing centres, for which considerable difficulties were experienced in getting minimum quantities of samples required. This field, in the initial stages of development of marine fisheries research, had its importance as nothing much was known about most of the species that constituted the different types of fisheries. From this type of data the Institute has been undertaking investigations in assessing stocks of different fisheries. This helps in creating a base for scientific advice for rational exploitation in pursuance of the objective of suggesting preventive measures rather than remedial measures to be taken after the fisheries are affected. However, not much work has been done on advancing knowledge concerning the effects of environmental conditions on different types of fisheries.

38.3.21 In the larger perspective, the National Institute of Oceanography (NIO), of the Council of Scientific and Industrial Research (CSIR), has been conducting research on the environmental aspects of the living resources, covering changes in physico-chemical factors, primary production, plankton density gradients, current systems off Indian coast, different types of circulation and mixing processes. These aspects constitute some of the basic information required for estimating the distribution of fish and changes in the fishing areas.

38.3.22 In view of the importance of studies on determining distribution and densities of different types of fish populations in space and time and correlating these with environmental parameters, we suggest that CMFRI in coordination with NIO, should lay greater emphasis, in its future programmes of research, on the effects of environmental factors on different types of fisheries.

38.3.23 Central Institute of Fisheries Technology: The Institute has three sub-stations and four research units. The research programme falls under two main categories, viz., craft and gear technology and processing technology. The research on craft and gear, includes the studies on the development of suitable gear designs for various types of operations and from different sizes of fishing vessels and designing of different types of craft for operation under various conditions. The Institute has developed standard designs for mechanised fishing boats, on the basis of which mechanisation programme gained momentum. However, research work in this section has been lacking in the studies on behavioural systems of different fish populations to gear and craft. Research has also been conducted on the use of different types of gear and craft materials. In its processing division, the Institute conducts studies on the fundamental aspects of fish biochemistry and microbiology. Besides, the Institute formulates and standardises methods for processing different types of fishery products, works out methods for effective utilisation of the byproducts and offers technical assistance in improving the quality of processed fishery products.

Gaps in the Resources Survey and Assessment

38.3.24 Summarising the present status of survey and assessment of marine fisheries resources of India, it has been shown that there is considerable gap in the ground to be covered with reference to bottom-trawling. The investigations on pelagic fisheries have been taken only with reference to oil sardine and mackerel, leaving all other pelagic fisheries resources now being exploited including lesser sardines on the east coast, to be still surveyed and assessed for increased production. There has hardly been any effort expended on the investigations of the gill net fishery for extension of operations beyond the present range of exploitation. On the introduction of midwater trawling as a new fishing method, hardly any attempts have so far been made. The gill net operations and midwater trawling would constitute important gear as most of the quality fish of India inhabit midwaters. The vessel effort for exploratory and experimental fishing with the two independent organisations of the Union Department of Agriculture, viz., Deep Sea Fishing Organisation and the Integrated Fisheries Project comprises, at present, 44 fishing units, and it will be supplemented by another 8 larger vessels to make a total of 52. As against this, the research institutes of the ICAR have hardly any vessel efforts of their own, although resource survey and assessment is mostly a scientific discipline pre-requisite for development of marine fisheries. Exploratory and experimental fishing constitutes only one component of this multidiscipline, as has already been seen in the methods adopted by the UNDP for investigations on oil sardine and mackerel.

Pattern of Resources Survey

38.3.25 The future pattern of resources survey and assessment should take into consideration the advancements made in the fishing technology in other countries, which is being increasingly improved. These advancements have been backed by considerable amount of integrated research and the areas open to fishing have extended further and further from the shore. This is because all the coastal fisheries resources have been nearly exploited to the maximum sustainable yield and operations have to be launched in the deeper waters.

38.3.26 Fishing units, contributing most of the world catch, continue to employ basically the same types of gear, viz., trawls, seines, gillnets and hook and lines which have been in use for many centuries. It is mainly the progressive development in the instrumentation as applied to fisheries in the last 20 years, which has brought about considerable change in the structural pattern of fishing units from the point of view of increasing their efficiency. The fishing units in the known fishing grounds have to spend considerable non-productive time in finding out commercial concentrations. It has been considered that 50 per cent of time is non-productive in botton trawling and as much as 80 per cent in purse seining. The advent of electronics followed by the installations of hydroacoustic fish detection equipment, viz., echosounders and sonars, has brought about the integration of the returned echoes in conjunction with a means of identifying the target which could offer a realistic promise of obtaining stock data over wide areas at reasonable cost. The application of telemetering instruments such as net-height telemeter, depth telemeter, temperature telemeter, tension meter etc., used in combination with the echosounder and sonar of fishing vessels has now enabled the observation of fish and their reaction to fishing vessels and gear. This has now made the introduction of one-boat midwater trawling a commercial possibility. The application of these instruments is also being taken advantage of in the bottom trawling and semi-pelagic trawling. The modernisation in the deck equipments, making hauling machinery more efficient, has led to the operation of very large nets and larger vessels. Particularly, the introduction of hydraulic power block has so much facilitated the hauling of very big purse seines that it has brought an extensive use of large purse seines in the high seas, creating conservation problems. Besides the hydroacoustic detection equipment on-board, systems have been adopted for location of commercial accumulations of different stocks in the high seas on the basis of coordinated fish searching and intelligence services to reduce still further unproductive sea time. The reporting of catch has been made obligatory in some countries so that the areas of good fishing are broadcast to other fishing vessels. Fishing charts are prepared, based on nautical charts with added information of fisheries interest. The skippers are encouraged to note on the charts additional information gained by them. The annotated charts are returned to the concerned establishment for updating on the basis of new data gained collectively by the entire fleet.

38.3.27 Recent advancements in marine fishing technology have shown that the task of resources survey and assessment in India could be undertaken by deploying a fewer number of fishery research vessels, say 8 to 10. These should, however, be well-equipped with modern instrumentation, with a scope of covering more grounds in a shorter time as has been exemplified by the UNDP investigations on pelagic fisheries. Such a research fleet would give more scientific and synoptic information on resources survey and assessment than what could be obtained by the operation of a large number of fishing vessels, which are not well equipped for the purpose and without any cohesion in work. The resource survey and assessment consist of two aspects, the prospecting of new or underutilised stocks of fish, and the monitoring aspect of assessment so as to maintain the stocks at the optimum sustainable yield. Prospecting would include the determination of commercial accumulations of different fishes in single or multi-species fisheries, their distribution and densities correlation of these features with environmental factors, behaviour of different stocks towards various types of catching methods and a preliminary economic assessment of exploiting the stocks newly discovered. The monitoring aspect is a continuous process of investigation for assessing different stocks of fisheries in relation to fishing pressure and changes in environment with a view to forecasting the magnitude of fisheries. It will thus be seen that the resources survey and assessment constitutes a multidisciplinary activity involving research in biological oceanographical, technological and economic aspects. Such an integrated approach needs to be developed and this should form now the pre-requisite to further expansion of marine fisheries.

38.3.28 In this context we are of the view that the DSFO in its present form has outlived its purpose. As a much better alternative to closing it down, it should be restructured in combination with IFP and completely divested of activities like day fishing and maintenance of an inefficient fishing fleet. It would be wasteful to continue the vessel-effort with as many as 52 inefficient fishing units, comprising 44 fishing vessels (some of them always limping) already in operation and 8 to be added, merely engaged in a repetitive type of exploratory and experimental fishing. Both these organisations, the credit institutions and the fishing industry have been repeatedly emphasising the need of essential data to project the fishing results in terms of economic considerations to formulate projects. Only such studies will enable the investment of capital for expanded marine fishing on commercial lines, whether in the private or public sector. It is also felt that there is need for an organisation in the public sector for setting an example in diversifying production by utilising those resources which have been discovered but are not being exploited by the private sector in the industry, because of economic uncertainties.

38.3.29 It may, therefore, be desirable to restructure these two organisations into one unit to take the form of Marine Fisheries Development Organisation or Corporation giving it considerable autonomy in operation, but setting definite time targets. Units of the DSFO rendered surplus by this should be wound up or transferred to State Governments or Corporations wishing to run them on a commercial basis. Useless vessels should be scrapped or disposed off without further loss to the public exchequer. The remaining vessels of the DSFO and the IFP should be regrouped into two fleets: (a) a research fleet for survey and assessment to be directed by the research agencies of the ICAR; there are very few research vessels now available but it is expected that others will soon be available for the CMFRI, and (b) a fishing fleet for experimental and commercial fishing to be handled by the proposed Marine Fisheries Development Organisation.

38.3.30 The resources and assessment being a research function, should be the responsibility of ICAR, through the CMFRI, in coordination with CIFT, NIO, and other Central and State fisheries organisations. The combined leadership of the programme may be vested in a senior scientist to be nominated by the ICAR from any one of these organisations but with unambiguous delegated authority for the framing and execution of survey and assessment programmes. Leadership can also be on a rotation basis for every three years.

38.3.31 Efficiency of operation of research vessels and their management call for expertise not normally available at the research institutes but the success in sea programmes would entirely depend upon it. Experience has shown that the prevailing government rules and procedures are not conducive to the maintenance of top level performance of the fishing fleet. It should be possible to establish services organisations for maintaining and operating research vessels at selected centres, either separately or contracted out to public sector agencies. All the vessels should be available for providing seatime to fishing operatives being trained and qualifying for certificates.

Preparation of Fishery Charts

38.3.32 In some countries where fishing industry is considerably advanced, progressive use is being made of fishery charts depicting environmental and oceanographic information, in addition to making use of usual navigational charts. The availability of such charts has provided the fishermen with a vital link in developing correct strategy for planning fishing trips. In India, only old Admiralty Charts are available to the industry for navigational purposes. There is, therefore, a need for preparing fishery charts. It has been reported that a revised set of Indian Hydrographic Charts based on the surveys conducted by the Indian Navy are being brought out. These charts would also be useful for the same purposes. Information already available on fishing grounds and environmental and oceanographic features, gathered by various agencies such as International Indian Ocean Expedition, NIO, CMFRI, DSFO and other marine biological and fisheries research organisations, should enable the preparation of an initial set of fishery charts which could be useful to the industry. Preparation of additional charts and superimposition of further data could then follow, as and when relevant data are gathered. It would be necessary to have a centralised agency for collecting the information and preparation of fishery charts. It is suggested that the Ministry of Agriculture and Irrigation should set up a working machinery, in coordination with Chief Civil Hydrographic Office, NIO, CMFRI and marine biological and fisheries research organisations for preparation of fishery charts.

4 PRODUCTION MEANS

38.4.1 The total complex of fishing units, comprising a variety of composite systems of two factors—craft and gear, constitutes the means of production. There are, however, various types of gear which are operated without craft in the inter-tidal waters. These contribute only such small units as hardly yield any appreciable marketable surpluses. They are generally not considered in the estimates of marine fish production of India. Besides craft and gear, another factor, which has influenced the evolutionary process of fishing units, has been the on-board preservation or processing of catch, resulting in the enlargement and speedy operation of crafts, mainly with a view to extending the range of exploitation. Fishing fleets of countries with well-developed fisheries comprise craft which are generally categorised into three types according to the distances of their operation, as given below :

(i) Small Distance Fisheries or Coastal Fisheries : Fishing craft may be mechanised or non-mechanised and are generally upto about 12 m in length. These vessels undertake daily trips.

(ii) Middle Distance or Offshore Fisheries : Fishing crafts are about 12-30 m in length. They have sufficient enduring capacity, with preservation facilities on board, to be away from home bases upto about a week or more. Seaworthiness of these crafts varies from region to region, but it is sufficient in the case of larger vessels in this range to undertake fishing operations all the year round, except during the stormy weather.

(iii) Distant fisheries or High Seas Fisheries: The fishing vessels are large, generally above 30 m in length, and are provided with modern navigational and fish finding instruments, and preserving and processing equipment on board. These vessels generally remain at sea for longer periods which may extend to 3-4 months at a time. The vessels are seaworthy enough to undertake fishing all the year round, under all sea conditions.

38.4.2 The means of production from coastal and offshore fisheries in India are discussed here. As the scope of distant fisheries or high seas fishing lies mainly in tuna fishing, the possibilities of its development are discussed in Section 5. It is not considered advisable to follow the system so far adopted, of developing the means of production as per the division of continental shelf into 20 m region, 80 m region and beyond as deep sea region.

Coastal Fisheries

38.4.3 Non-mechanised Craft: The various types of traditional fishing craft of India, indigenously designed, are so adapted as to suit the sea conditions of the east and the west coasts. The sea on the east coast is rough, the surf breaks heavily on the coast and the sheltered places are very few. On the west coast, the sea is calm, except during southwest monsoon when fishing operations are almost suspended. The salient features of the main types of craft employed on the two coasts are given below:

I East Coast

(i) Catamaran: It is the keelless raft formed by lashing together several logs, curved and shaped like a canoe. The logs may be held together either by ropes or by pegging with wooden pieces. There are localised modifications of the catamarans such as Orissa and Ganjam types, Visakhapatnam type, Coromandal type, boat catamaran and raft. The latter two types are found off southern maritime of Tamil Nadu and Kerala on the west coast. They vary in sizes, extending up to about 8 m in length.

(ii) Masula boat: It is a non-rigid boat constructed with planks sewn together with coir rope but without frames or ribs so as to withstand the severe knocking of the surf. There are various patterns such as *bar* in Orissa and *Padava* or *padagu* of Andhra coast. A variant with ribs inside has been developed in some parts of Andhra Pradesh. The boats are upto about 8 m in length, although they are generally smaller.

(iii) Carvel boats. The *dingi* and *nauka* are well-designed boats of West Bengal and Orissa ranging upto 13 m in length. The *nava* is an important craft of Andhra Pradesh which is a keelless sailing boat, strong enough to land it with full load on sand or beaches, even in surf. The Tuticorin type of carvel built boat is smaller in size, about 11 m in length.

II West Coast

(i) Dugout canoes: As the name implies the canoe is made by scooping out a large log of wood, making the keel portion thicker than the sides. These are predominantly used in Kerala and southern parts of Karnataka and comparatively fewer numbers are found in Maharashtra and Gujarat; canoes are also used in some parts of the southern coast off Tamil Nadu. In Kerala the largest size of *odam* or *vanchi*, (10 to 13 m). middle size—*thonies* (9 to 10 m), and smallest size *beputhoni* (8 to 9 m) are used for operating boat series, drift nets and long lines. There are plank-built canoes which are dugouts with planks fixed on the sides. They are largely used in Kerala for boat seines. This type is also seen in some parts of Gujarat and Maharashtra. Another type is the outrigger canoe which is called *rampan* boat in southern parts of Maharashtra and northern parts of Karnataka. These craft are built with a narrow keel, but differ from plank built canoes in that planks are more spread out. They are larger in size, upto 15 m in length. There is also an auxiliary—the outrigger on side alone.

(ii) Built-up boats: These are the best types of indigenously constructed craft and are mostly operated in the north west coast of India mainly from Ratnagiri northwards in the States of Maharashtra and Gujarat. They vary in size ranging mostly between 12 and 15 m in length. The most noticeable feature of all the craft of this region is the long bow and the rather abrupt and rounded stern. The bow shape in profile varies from place to place, giving the boats specific features such as *Satpati* type, *Bassein* type, *machwa* etc.

38.4.4 The traditional fishing craft, as per the Indian Livestock Census 1966, consisted of 117,575 units, comprising 43,909 catamarans, 28,306 dugout canoes, 17,059 plank built boats of 9.75 m and above, and 28,301 similar boats less than 9.75 m length. This fleet is of considerable importance, as it contributes annually as much as about 0.7 million tonnes of marine fish production, with an average of about 6.0 tonnes per craft per annum. The Statewise distribution of these four types of craft is given in the Appendix 38.3

38.4.5 Mechanised craft : The motorisation of the existing traditional craft by installing engines was an initial step taken in the programme of developing mechanised fishing fleet of India. The survey undertaken had shown that the *machwa* of Gujarat, *Satpati* and *Bassein* types of boats of Maharashtra. Tuticorin type of boat of Tamil Nadu and *nava* of Andhra Pradesh were suitable boats for this purpose. Motorisation of several of the existing craft first started in Maharashtra and was subsequently followed in other States. In Tamil Nadu, a few Tuticorin types of boats were motorised on an experimental basis; however, this was not readily accepted by the fishermen and the scheme was discontinued. In Andhra Pradesh the trials of motorisation of *nava* had shown encouraging results but there was the necessity of modifying the design; several boats according to the revised design were built in the State as additional introductions.

38.4.6 The majority of the traditional craft had comprised canoes and catamarans which were considered unsuitable for motorisation. The problem of bringing in improvements in the craft in the areas where these constituted the main fishing effort, had still remained. The logical step was to evolve a suitable small open motor boat as a beach-landing craft. Several types of mechanised beach-landing boats were known in the various parts of the world. But even in those countries the launching and hauling them on the beach had necessitated elaborate shore arrangements. The initial attempt was made in this direction and a prototype was made in Kerala with the help of the foreign technicians of the INP. Subsequently, naval architects of FAO in India had designed and fabricated prototypes and conducted experiments in Tamil Nadu and Andhra Pradesh. As the landing and hauling of this motorised beach craft still required elaborate arrangements, expert opinion and usage did not favour their introduction as a substitute for canoe and catamaran in India.

38.4.7 Simultaneously, the question of introducing small mechanised harbour craft had also received attention. The initial consideration in designing suitable craft was to facilitate the operation of traditional fishing gear known to fishermen.

38.4.8 Mechanised boats of several designs were introduced in the industry since 1953. Initially, the base of mechanisation programme was the design popularly known as "*pablo*" meant for gillnetting. Consequent upon the introduction of trawling, necessary design of trawlers were introduced. The INP successfully introduced new designs in

Kerala. The new designs introduced in other States were those made by FAO naval architects and later by the CIFT. The CIFT has brought out the necessary detailed specifications of the mechanised boats of wood, ranging upto 15.4 m in length. The programme of mechanisation of fishing craft has been the most significant aspect of development in the means of production. The progressive total number of mechanised boats by the end of each Plan was as follows:

Pre-Plan period	13
First Plan	863
Second Plan	2,236
Third Plan	5,206
Three Annual Plans	7,608

The number of mechanised boats in operation by the end of the Fourth Plan, was 10,639 and their distribution then in different maritime states was as follows :

Gujarat	2,000
Maharashtra	2,918
Goa	168
Karnataka	1,100
Kerala	2,014
Tamil Nadu	1,800
Andhra Pradesh	240
Orissa	122
West Bengal	5
Pondicherry	151
Andamans	2
Lakshadweep	115
Total	10,635

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The Fourth Plan target was to introduce additional number of 5,500 mechanised boats to reach a level of about 13,000 fleet strength. However, owing to the process of decommissioning of boats after service of about 10 years or in some cases even earlier when boats were not properly maintained, the effective strength had shown a reduced number which otherwise should have been around 12,000. Considering even this, it is seen there was a shortfall of about 1,000 boats in the Fourth Plan, indicating that the rate of mechanisation had gone down.

38.4.9 The decommissioning of mechanised boats for the operation of the coastal fisheries, without the replacement of equivalent number would tend to cause gradual decrease in the effective strength of the fleet, bringing about a serious situation in the means of production. This situation arises out of the fact that the cost of the mechanised boats has more than doubled during the last few years. The owners of the boats, in most of the cases, have not realised the economic liability of setting aside the depreciation amounts as a sinking fund for purchasing a new boat or a new engine. Besides, those fishermen who had received subsidy for the first boat or the engine, are not entitled to the facility of repeat subsidy. In this context, we recommend the grant of preferential loans as suggested in the paragraph 38.8.20. This could be linked up with the compulsory saving of depreciation amounts as a sinking fund, which in the course of 10 years or so, along with compound interest, would facilitate replacement of the worn out engine or the boat.

38.4.10 It is observed from the Statewise numbers of mechanised boats that the programme of mechanisation has not made significant progress in the States of Andhra Pradesh, Orissa and West Bengal. In other States, there would be scope for additional introductions of mechanised boats in the coastal belts which have not yet been adequately exploited. It may be mentioned that the grant of subsidies of different levels by the maritime States has been an important factor of financial assistance to the weaker sections of the community, i.e., fishermen in the furtherance of the programme of mechanisation. The levels of subsidies are, however, being progressively scaled down. On the other hand, the cost of mechanised boats has nearly doubled during the recent years. This situation has affected the progress of mechanisation. We, therefore, recommend that the withdrawal of subsidies by the State Governments should not constitute a constraint in the progress of introducing mechanised boats in the coastal fisheries.

Offshore or Middle Distance Fisheries

38.4.11 In the context of the definition of this level of fisheries, it can be stated that several of the larger size of the traditional boats, most of which had been subsequently motorised, have been operating in the offshore waters even upto 80 m depth. These boats mainly operate gillnets and long-lining from Maharashtra and Gujarat coasts. These have improvised arrangements for cooking, sleeping and taking ice in insulated boxes, so as to remain on the sea for about 5 to 7 days.

38.4.12 Fishing vessels of steel hulls. In developing the middle distance or offshore fisheries, the Ministry of Agriculture and Irrigation has so far been following the policy of favouring the introduction of only steel trawlers, and evaluating the progress mainly in terms of the number of such vessels introduced in the industry. The Department had considered that this was the logical sequence to the large scale introduction of small mechanised fishing fleet with wooden hulls as this had given a boost to the industry, mainly in earning of foreign exchange. Accordingly, the Department had envisaged the introduction of 300 larger vessels of steel hulls in the Fourth Plan itself. This was quite an ambitious planning as neither the necessary infrastructure was available to warrant this magnitude of development nor was there adequate knowledge of the deep sea resources as reported by the Department. This phase of development was probably influenced by mere belief in the existence of substantial deep sea resources and to take necessary steps as early as possible to bring all possible resources into utilisation.

38.4.13 While considering the first phase of introduction of steel vessels in the industry, the Government desired to procure steel vessels from abroad, but the Indian ship builders represented to the Government that there was sufficient capacity and capability in the country to fabricate fishing vessels of steel hulls. The bulk order of 40 medium-size fishing vessels of 17.5 m length was placed in 1968 by the Government of India for the requirements of vessels in the public sector with the ship builders who had organised themselves into two consertia, one on the east coast and the other on the west coast. The uniform plan and design of these vessels were finalised after seeing the performance of similar imported vessel in the exploratory and experimental fishing undertaken by the DSFO. Not only was the delivery of the vessels much behind the schedule, the performance of the vessels was also found to have several defects which had caused considerable operational difficulties. Thus, this initial efforts to build fishing vessels with a large percentage of indigenous components created an impression that even the public sector was reluctant to operate such vessels, tending to create diffidence in the fishing industry to place orders for such vessels. This situation was examined in this Commission by arranging a meeting which was attended by the Directors of Fisheries of maritime States or their representatives, officers of the Central Fisheries Organisations and a representative of the ship-building industry. It was brought out in the discussion that the main defect pertaining to the design was the positioning of the wheelhouse on the top of the superstructure, making the vessels unsteady. Defects were pointed out with regard to working of various items of equipment, such as remote control, fuel pipe, gearbox, winch and power take-off, electrical appliances etc.

38.4.14 The representative of the ship-building industry explained that the main consideration governing the position of the wheelhouse on the top of superstructure was the requirement of an all round view for effective control of instrumentation located in the wheelhouse. The single lever remote control was not upto standard, and the consignees were advised to adopt the new system. Defects in fuel pipe were rectified by the individual shipyards. Defects in the gearbox were referred to the engine manufacturers who took a long time to rectify the same resulting in the vessels remaining idle for long periods. With regard to winch and power take-off, the trouble was experienced in all the trawlers, and this was rectified subsequently. For defects in the electronic equipment, it was explained that these items were supplied by their manufacturers and the malfunctions had to be rectified by the suppliers and the responsibility of shipyards was limited to wiring and fittings. As regards the lack of sea-kindliness, it was explained that the stability of the vessels was in accordance with recommendations of the International Maritime Consultative Organisation. It was, however, possible that vessels might be overstable with the result that the return to upright position was rather quick. This movement might have been uncomfortable while fishing in rough seas.

38.4.15 The aforementioned situation was considered to be arising from the part responsibility of the ship-builders, which was not conducive to the development of steel vessel construction industry in the country. It was, therefore, felt that ship-builders should take complete responsibility for the satisfactory operation of the entire vessel with reference to design, fabrication, equipment and also undertake necessary maintenance and repair services.

38.4.16 We, therefore, recommend that the fabrication of fishing vessels with steel hulls in the country should be limited to those ship building yards which are willing to specialise in fishing vessels, execute the orders in reasonable time and be responsible for satisfactory working of the complete vessel including its repair and maintenance. By specialisation, these yards could also develop a system within their organisation to improve the design and equipment thereby making construction more economical and operation more efficient.

38.4.17 In the next phase of developing the deep sea fishing scheme, the Government of India permitted in 1968 the import of 30 steel trawlers with the condition of placement of orders for indigenous vessels on the basis of 2 imported : 1 indigenous, all 17.5 m or above in length. This step being capital intensive in nature in procuring three vessels at a time, had the characteristic of limiting the scheme to the benefit of mostly the corporate sector which had the capability to make necessary investments. The Planning Commission, in its Mid-term Appraisal of the Fourth Plan, drew attention to the lack of progress in the scheme of introducing 300 larger fishing vessels and urged that suitable steps should be taken to remedy the situation. In pursuance of this, a scheme was introduced in 1970 by the Government to help the purchase of indigenously constructed deep sea fishing vessels by providing a subsidy of 27½ per cent on the cost of corresponding imported vessels. These steps of allowing imports of steel trawlers and granting subsidy on indigenous steel vessels too, did not result in the satisfactory progress as it was reported that there were only 10-12 vessels in operation out of 30 which were to be imported and no party had fulfilled the obligation of introducing indigenously constructed vessels. There were various reasons attributed to this shortfall, viz., (a) lack of proven designs of larger steel trawlers for indigenous construction; (b) lack of necessary credit facilities from financial institutions; (c) lack of arrangements with ship-building yards for accepting deferred payment terms for indigenously constructed vessels; and (d) financial institutions complaining that the preparation of projects did not satisfy conditions as bankable propositions. Because of the prevalence of these lacunae in the system, several applicants had dropped the idea of getting vessels under this scheme.

38.4.18 In the third phase the Government of India, in 1973, allowed for the second time the import of 50 fishing vessels, mainly steel trawlers in the size range of 23-25 metres and 30-35 m with stipulation of 1 imported : 1 indigenously constructed. It has been reported that under this scheme, arrangements have been made for obtaining designs and detailed shop drawings from the concerned ship-building yards in foreign countries. The parties would be required to construct the same type of vessels at the ship building yards in the country on the basis of these designs. There is an implication in the scheme, as it was in the previous scheme, that the marine products should be exported to earn foreign exchange equivalent to the value of imported vessels in a period of three years.

38.4.19 It appears that the Government had taken the aforementioned steps to quicken the pace of development of offshore fisheries through the import of as many as 80 steel trawlers, alongwith the introduction of 65 indigenously constructed vessels, stipulated under import conditions—all vessels above 17.5 m in length. This step has been mainly directed towards the objective of accelerating the progress so as to reduce the gap in the backlog of Fourth Plan commitments of introducing 300 deep sea fishing vessels.

38.4.20 On the other hand, it is advocated by FAO that the fishing vessel construction industry is an integral part of the development of offshore fisheries. The most important factor in fishing vessel construction is to arrange types and sizes of steel vessels for different fisheries which will have the necessary operational and economic efficiency before their indigenous fabrication for commercial exploitation is undertaken. Designing of fishing vessels is in general a time consuming process. As such designs of fishing vessels of proven value may be necessary phase in designing steel vessels after taking into consideration various local conditions. Mere designing of boats on paper may not necessarily constitute a guarantee that it would hit the mark unless a prototype is fabricated and its performance investigated. The investigations of establishing types and sizes of vessels go hand in hand with the studies on bear either for introduction of new types of fishing vessels or for improving the existing types of gear.

38.4.21 In the light of these consideration we are of the view that the Government has already taken more than adequate steps in importing larger trawlers and further import of larger trawlers beyond the numbers which are in the pipeline should be done only after careful consideration. However, the import of prototypes should be allowed or even encouraged as this would help the indigenous fishing vessel construction industry which is considered an integral part of the development of offshore fisheries. The CIFT should strengthen its craft and gear section with personnel qualified in naval architecture for developing designs to suit Indian conditions.

38.4.22 Another objective of the Government in the import of larger vessels of steel hulls for bottom trawling has been towards increasing export of marine products. The implication of earning foreign exchange and the high capital as well as operational cost of these larger vessels would naturally create a tendency, as has already been experienced in the operation of such vessels, of directing the fishing effort towards catching prawns as the best economic commodity wherever these would be available. Except for the deep sea prawns which are at present not exploited by commercial fishing fleets, the presently known resources of prawns of exportable quality have almost reached the maximum sustainable yield. This would indicate only a marginal increase which would not necessarily need the induction of such highly capitalised vessels. It may, however, be argued that the present knowledge about the commercial availability of prawns in the deeper waters is not adequate. This would then constitute the only justification in deploying such a fleet of larger fishing trawlers which would involve exploratory work in the initial stages in the expectation of finding out suitable grounds and then establish operational bases accordingly. But the important consideration would be as to what would happen if suitable prawn grounds in deeper waters are not found to adequately support such a fishing fleet of larger vessels. The inevitable situation would then arise that either the vessels would be economically inoperative or the fishing effort would be concentrated in the coastal fisheries only with the probable justification that the endurance capacity of such larger vessels could be utilised with longer radius of activity. This would then create a conflict of interests of operation of smaller vessels and larger vessels in some of the areas of coastal fisheries. It is learnt that the reports have already been received by the Government of India from certain maritime States regarding clashes between the operators of small mechanised boats and larger fishing vessels. Incidents have also occurred amongst the operators of non-mechanised and mechanised fishing craft, and amongst the fishermen in adjoining States. We recommend that the Government should take necessary measures for delimitation of fishing zones through legislation, with necessary provisions to avoid the possibility of any conflict in future.

38.4.23 It has been reported that in the operation of larger fishing vessels provided with either freezing facility on board or refrigerated fish hold, it is found more economical to process or preserve only a portion of the catch constituting prawns and some prime fishes, whereas the rest of the catch comprising lesser varieties of fishes is thrown overboard. This is a wasteful type of production and utilisation of the resource which in other countries, is being prevented by the installation of 'pocket' size fishmeal plants on board for utilisation of trash fish. We, therefore, recommend that the practice of discarding the trash fish overboard should be curbed, and if need be, the possibility of installation of 'pocket' size fishmeal plants may be examined. Further, it should be made obligatory for all the vessels above 25 GRT to report the catch in terms of quantity and quality to CMFRI.

Fabrication of Fishing Craft—Hull Materials

38.4.24 Wood and steel have long been in use, all over the world, for fabrication of fishing craft. As such, these are considered conventional materials. In the last thirty years, modern materials, viz., fibreglass reinforced plastic (FRP), aluminium alloy and ferro concrete have been increasingly introduced in the fishing craft industry.

38.4.25 Wood : India has progressively developed both skills and facilities in fabricating coastal cargo boats, traditional fishing craft and, in the last twentyfive years, mechanised fishing boats. There are about 69 wooden boat building yards in the country (Appendix 38.4). Besides these, fabrication of small traditional craft by the side of several fishing villages is a common scene. Most of the plank-built boats are built of timber of Indian teak (*Tectona grandis*). The dugout canoes are scooped out from the logs of mango (*Mangifera indica*), *chini* (*Tetramelos nudiflora*), piney (*Vateria indica*) and *aveini* (*Artocarpus hirsuta*). The catamarans, were being made from the imported logs of *Melia dubia* from Ceylon, but now indigenous logs of *Albizia procera*. *A. lebbeck* and *Ailanthus excelsa* are mostly used. Other boat building timbers for planks and frames in common use, are venteak (*Lagerstroemia lanceolata*), *babul* (*Acacia nilotica*), *sal* (*Shorea robusta*) and a few others.

38.4.26 The wooden craft are generally subject to severe damage due to attack of wood-boring and fouling organisms. Frequent application of anti-fouling paints retards to some extent the action of fouling organisms. However, the most effective prevention is the provision of sheathing of copper, aluminium alloy or fibreglass coating, on the portion of hull below the water line.

38.4.27 There are about 44,000 catamarans and 28,300 canoes. Taking the life of these craft as even 20 years, it would mean that nearly 5.0 per cent of these craft would need replacement every year. It has been estimated that narly 3,000 tonnes of logs would be required only for this purpose. It has been reported that considerable difficulties have been experienced in the recent years in obtaining the logs. As such, the use of alternative materials in the fabrication of these craft would assume progressive importance. However, use of timber, in general, would continue to be the prevalent material for fishing craft industry in India, because of its easy workability, facilities for construction already created and technical ease in construction. It is generally considered that wooden craft are economical upto the size of about 18 m length.

38.4.28 Steel: As compared to wood, steel is more suitable and economical material for vessels above 18 m in length. It has also lower maintenance cost. Another advantage of steel hull is that deformation of hulls does not take place. In a wooden boat the deformation of shape affects the alignment of the engine which in turn, has to be corrected frequently. The steel vessels are, however, susceptible to corrosion which necessitates repeated coating of anti-corrosive paints.

38.4.29 Fibreglass reinforced plastic (FRP): The FRP boats upto 30 m in length have been introduced in the field of fishing industry of the world. It has been reported that larger vessels upto 60 m length can be fabricated to satisfaction. The material is ideally suited for mass production. The advantages are: (a) light weight and high strength; (b) protection from corrosion; (c) very low incidence of attack of borers; and (d) increased pay load capacity. FRP boats require comparatively greater initial investment, but the cost can be reduced under mass production because the assembly is from moulds. High cost is offset by comparative reduction in the expenditure on the maintenance of hull and operation of the boats. FRP boats, 9.7 m in length, are fabricated in India and a few boats have already started fishing operations. A reasonable reduction in the cost of the raw material, i.e., fibreglass and the resins, and mass production of the standard designs of fishing crafts in suitable size ranges could only make FRP boats an acceptable proposition.

38.4.30 Ferro concrete: It is the name given to a material consisting essentially of a number of layers of galvanised iron wire mesh and steel rods impregnated with mortar made out of fine sand and cement. The material is easy to fabricate without the use of moulds. The thickness of the material, on completion, is only 18-25 mm. The hulls of this material are easy for maintenance and repairs. They have the longest life in water. Ferro concrete boats, having lengths 10.7—13.7 m have weight comparable to boats made of wood, steel or FRP, but above 13.7 m they would be lighter. From the point of view of economics, experience elsewhere has shown that 12-18 m ferro concrete hulls are likely to give satisfactory service if constructed by using standard materials such as steel, cement and sand, besides clever workmanship. However, this material would still require a further period of development with reference to civil engineering aspects and mechanical properties. In India, a start has been made in fabricating 9.7 and 11.6 m ferro concrete boats and it has been reported that the cost of these hulls is a little more than the wooden hulls. The introduction of ferro concrete boats will have some prospects in India if steel and cement are available at reasonable rates.

38.4.31 Aluminium alloy : After the development of marine type of aluminium-magnesium alloy and its welding technique, the material has been used in fabricating hulls of comparatively smaller boats (8-10 m) and the superstructure of larger crafts. The alloy is resistant to see water corrosion and biological degradation; it does not warp or absorb moisture. It gives the vessel a light weight, greater speed per hp and low cost of maintenance. One of the main disadvantages, however, is the adverse effect of heat on its strength characteristics. The material is available in India. Some of the inland fishing craft are made of this alloy. The recently introduced 17.5 m trawlers have their entire superstructure built of this alloy.

38.4.32 Comparative cost : While considering the two important components in the construction of the mechanised fishing vessels, i.e., the hull and the engine, the cost of the hull is an important economic determinent. It would, therefore, be necessary to have an idea about the comparative cost of hulls of different materials for small mechanised boats and for larger fishing vessels.

38.4.33 In the category of small mechanised boats, steel is generally considered as an uneconomical material for hulls. The comparative cost of hulls of wood, FRP and ferro concrete is given below :

size of hull(m) . .	Wood 9·7	FRP 9·9	ferro concrete* 9·7
cost of hull (Rs.) . .	51,000	95,000	60,000
normal life (years) . .	10	20	20
per annum depreciation cost(Rs.).	5,100	4,750	3,000

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* The actual cost of ferro concrete hulls is not available, but is reported to be slightly higher than the cost of wooden hulls; it is, therefore, given only as an approximate estimate.

It would be seen from the figures given above that although the FRP hulls and ferro concrete hulls require higher initial investment, but considering their normal life as 20 years, their per annum depreciation cost works out to be lower than that of wood. Besides there are several other economic advantages particularly in the FRP hulls regarding the cost of maintenance and operation.

38.4.34 In the category of larger sizes of fishing vessels, an illustrative example of comparative costs of a hull of 17.4 m on the basis of different materials used for its fabrication are given below:

Material used	Cost (Rs.)	Normal life in tropical waters (years)	Depreciation per annum (Rs.)
1. steel hull with aluminium superstructure.	5,50,000	15	36,666
2. wooden hull (without hull sheathing)			
(i) conventional wooden trawler, teak/GI fastenings.	(a) 2,25,000 (Gujarat region)	10	22,500
	(b) 2,40,000 (Andhra Pradesh)	10	24,000
	(c) 3,75,000—4,25,000 (Kerala, Karnataka, Tamil Nadu and Pondicherry).	10	37,500—42,500
(ii) cheaper version of CIFT Venteak and other treated wood with G. I. fastenings (Kerala built).	2,10,000	10	21,000
3. fibreglass reinforced plastics. 'A' glass/polyester resin	8,50,000 (average of 5 hull basis).	20	42,500
4. ferro concrete	2,00,000 (approximate)	20	10,000

38.4.35 It is evident from the figures that ferro concrete is the cheapest material, but its usefulness in the fabrication of such large size vessels is yet to be determined. Comparing the steel and FRP materials, the difference is not appreciable considering the advantages of the former. As regards the wooden vessels there is a considerable difference in the cost of hulls in different maritime States. Except Gujarat and Andhra Pradesh the depreciation cost of wooden boat is, however, comparable with that of the FRP boat.

38.4.36 In the light of the comparative features of different hull materials discussed above, we are of the view that, in addition to conventional materials, viz., wood for the fabrication of fishing craft upto 18 m in length and steel for larger vessels, the FRP would play an important role only when mass scale production of craft of uniform sizes is found necessary with economic advantages over the craft of conventional materials. In this context, the CIFT should first examine the details including economic considerations and the possibility of substituting worn out canoes and catamarans, as considerable difficulties are experienced in the availability of requisite quantities of logs for annual replacements. As regards ferro concrete craft, this Institute should investigate in detail the technical aspects and economic advantages over the craft of other materials.

Marine Diesel Engines

38.4.37 Marine diesel engines upto about 350 Brake Horse Power (BHP) are manufactured in India. Fishing craft of different sizes, or of the same size but undertaking different types of fishing methods, would require engines of varying capacities, depending upon the distance of fishing grounds, speed desired, towing of gear as in the case of trawlers, driving fishing gear-handling accessories such as trawl winch or power-block, and driving auxilliaries such as generators, pumps, etc. Generally, the trawlers require engines of higher capacity than the corresponding size of other fishing craft. From the engine capacity point of view, it can, therefore, be stated that the fishing craft rigged for trawling could serve as a multipurpose craft, particularly for either gillnetting or longlining if necessary facilities, such as bunkering space for storing gear, hauling equipment etc. are planned at the time of fabrication of the vessel. Approximate range of engine capacity for different sizes of trawlers alongwith their respective displacement tonnage, is given in the following statement :

size of boat overall length (m)	9·1	9·7	11·0	12·2	15·2	18·2	24·4	30·5
displacement tonnage	5·5-6·0	8·1-9·1	15·0-16·0	17-18	30-32	45-50	90-100	200-250
power of main engine (BHP)	30-45	40-45	60-70	80-90	150-160	200-250	300-350	450-500

38.4.38 The programme of mechanisation of fishing fleet, in the initial stages, depended on imported engines. With the increasing manufacture of indigenous engines, the imports had to be eventually stopped. This, however, gave the fishing industry an opportunity to realise the differences in the general performance of the imported and indigenous engines. The industry has often complained about the quality of indigenous engines. The reliability, performance and price of indigenous engines constitute factors of considerable economic importance in the operation of the mechanised fishing craft.

38.4.39 It has been reported that the cost of engines has already doubled in the last ten years, and is disproportionately higher than the imported engines. The rated horse power is not generally achieved The consumption of fuel and lubricating oil is comparatively higher than in the case of imported engines. The spare parts are very costly. The overall position regarding the availability of spare parts and service facilities is not satisfactory.

38.4.40 As regards the quality of engines, it has been reported that the Government has taken up the issue with the manufacturers who have assured the Government of effecting necessary improvements. There is, however, a need of working out standard tests to determine the reliability of engines for issue of a certificate of Indian Standards Institution (ISI). As craft and gear section of the CIFT has been examining the question of the quality of engines, it is suggested that CIFT should work out necessary standards in consultation with ISI, for certifying the quality of engines. The question of reasonable guarantee period of the engines should also be considered. It would also be necessary to direct the manufacturers to provide repair facilities at the important fishing centres so that the fishermen do not lose fishing time due to engine breakdowns.

38.4.41 As regards the high price of indigenous engines, the possibility of reduction in price was taken up by the Government with the manufacturers. The latter, however, had represented that reduction was not possible owing to considerable rise in the cost of raw materials and wages of labour. This issue needs examination in details to see that there is no undue profitability in the supply of indigenous diesel engines, for fishing industry. The feasibility of limiting their manufacture to reduced number of industrial units may also be looked into, since the annual requirement of marine diesel engines is comparatively small. Another factor in the consideration of reduction in price is the relief in central excise duty and State sales tax on diesel engines. It has been reported that since most of the State Governments have been reluctant to give exemption of sales tax, it has not been possible to give relief in the Central excise duty. We recommend that the possibility of giving relief in the sales tax and excise duty should also be examined.

Fishing Gear

38.4.42 There are a number of different types of traditional gear indigenously developed by the fishermen in exploiting different types of fisheries. There are also different types of gear employed in exploiting the same type of fishery in different regions, particularly in case of sardines and mackerel. In spite of these variations, there seems to be some regional homogeneity in the operation of traditional gears. Leaving aside the description of the numerous types of fishing methods of minor scale mainly for subsistence fishing, the gear used for commercial fishing in India are discussed in the following paragraphs.

38.4.43 Gill-nets and entangling nets: These are single walled nets which may be of the set or the drift type. The drift nets are of considerable importance in catching most of the prime varieties of marine fishes. The operation involves the drifting of the boat as well as the net along with the current and the tide. The fish, while moving about are either gilled or entangled. A bottom-drifting net is characteristic of Gujarat and Maharashtra coasts, for catching pomfrets and *dara*. On the coast of Karnataka and Kerala, the drift nets are of the surface type mainly meant for shoaling fish such as sardines, mackerel etc. Surface drift nets are also used on the east coast for catching lesser sardines. Similar nets with larger meshes are used mainly for catching seerfish, tunnies and catfishes.

38.4.44 Seines: Seines are mainly of two types as discussed below:

(i) Shores seines: These are common along the S.W. and S.E. coasts of India. The shore seines on the east coast are invariably with bags, and scarelines are often used to drive the fish into the bag. The biggest sized shore seine, popularly called *rampan,* is a wall like net mostly operated in the Konkan region. One extremity of the net remains on the shore, while a boat carries the rest of the net and pays it out in a semicircular manner and brings the other extremity to another point on the shore. The two ends are then dragged on the shore by two parties, each of 10-15 fishermen. mainly shoaling fishes like sardine and mackerel are caught in it.

(ii) Boat seines: These are conical nets with or without wings and are mostly operated on the coast of Kerala, Tamil Nadu and Andhra Pradesh. They are either single boat type or two boats type. Several scaring devices are followed, such as beating on the sides of boat, beating on the water etc., to drive the fish shoals into the net.

38.4.45 Stationary bagnet: It is a large conical bagnet, popularly called *dol* net, which is fixed to the strong wooden piles, driven into the sea bottom even in the regions upto 30-40 m depth. All types and sizes of fishes and prawns, which have the habit of moving inshore with the flood tide are liable to be caught on their return with the ebb. The *dol* net fishery is the most important fishery of Gujarat and Maharashtra States.

38.4.46 Hook and lines : Hook and line fishing consists of four types—headlines, longlines, pole and line and trolling lines. In handline fishing, the gear simply consists of a single vertical line, sinker and few baited hooks in series. This method is mainly used for catching perches, snappers and similar fishes from the rocky beds. Longline fishing is the most important commercial gear of this category. It consists of a very long horizontal mainline with vertical branches spaced at uniform intervals, each branch bearing a series of baited hooks. Most of the large sized predatory fishes such as sharks, rays, catfishes, etc., are caught by this gear. Pole and line fishing is mainly conducted for catching skipjack and younger specimens of other high seas tuna. The gear consists of a bamboo pole with a cotton or nylon loop laced at the projected end to which is tied a heavy cotton or nylon line of about one metre length leading to a short wire bearing a barbless hook. Trolling lines are mainly single lines, bearing baited hooks or artificial bait. This gear is mainly operated from some parts of Kerala and Tamil Nadu for catching seerfish, tunnies and other similar fishes.

General Considerations

38.4.47 Most of the marine fishermen have, for generations, confined themselves to the operation of one and the same type of gear, without any recourse to the change for more productivity and economic returns. The desirability of effecting such a change, either by making improvements in the existing traditionl gear, or by substituting one type of traditional gear with another type found more productive and economical elsewhere in the country, or by introducing a new gear in the country, cannot be overemphasised. It would be necessary in this context to study the traditional gear systems in all the requisite aspects of gear characteristics which would enable undertaking convincing demonstrations to the fishermen. In the field of gear research, except for the studies on their structural details, hardly any studies have been undertaken on the relative efficiency of different gear systems operating in the same type of fishery. We, therefore, recommend that craft and gear section of the CIFT and the fisheries research organisations in the maritime States should intensify research in coordination, on the traditional gears with a view to bringing about improvements in productivity and economic returns to the marine fishermen.

38.4.48 Bottom Trawling : The operation of a trawl net for exploiting demersal fishery is one of the oldest gear discovered around 1870 in England. It was, however, introduced in India as a commercial gear somewhere around 1950, although some experimental attempts were made earlier. There are several types of trawl net operations with varying arrangements to keep mouth open, but the most common method employed all over the world is trawling with a pair of otter boards. Besides, there is side trawling, stern trawling, two boats or bull trawling, one boat rigged with two trawlnets as Mexican shrimp trawlers etc. The principle in all these methods is to drag a bag net, provided with wings, along the seafloor on the support of two warps of wire ropes payed out from a winch worked generally by the main engine of the vessel.

38.4.49 The scope of trawling, which was originally associated with bottom trawling, has, in the last twenty years, been extended to cover midwater and sub-surface fisheries. This has been possible as a result of intensive effort and strong research support. The midwater trawling and semi-pelagic trawling have now been established as commercial fishing methods in several countries, but these are yet to be introduced in India. The introduction of midwater trawling will have considerable importance because of prevelance of several fisheries of commercial importance in this zone. Some attempts have been made in the country, but research has to be intensified with a view to examining the possibilities of commercial introduction of midwater trawling.

38.4.50 Purse seining : Purse seine is a large sized wall-net which is payed out in such a way as to encircle a school of fish. A pursing cable, passed through the rings under the net is pulled to close off or pouch the bottom of the net, thus trapping the fish. Originally, the operation was conducted from two boats, but with modern advancements, one boat purse seining in conjunction with the use of power-block became a noteworthy technological development in the fishing industry. The power block — a considerable labour-saving device, enabled the hauling of major part of the net aboard, until the fish were sufficiently concentrated in a small pouch drawn nearest to the vessel, from which larger fish such as tuna are brailed out and small fish are pumped out in the fish hold.

38.4.51 The underlying idea in extending the trawling operations to mid-waters and semi-pelagic zone, and purse seining from pelagic to mid-waters by using very large and deep nets, was mainly to bring in intensive methods of production in capture fishing technology, replacing less productive methods such as gillnetting and long-lining. These were originally developed to increase the efficiency in operation and not necessarily to increase the total yield because most of the countries had experienced the difficulties in getting adequate labour and in operating fishing vessels with high cost of labour. However, these methods have been useful, all over the world, in exploiting the underutilised stocks economically from more distant waters and as such, the association of foreign expertise would be advisable. We recommend that the studies on the introduction of these new types of fishing methods should be intensified as most of the fisheries resources of India are pelagic, semi-pelagic, midwater and epibenthic, seeking foreign expertise wherever necessary.

38.4.52 Gear materials: Fishing nets, prior to about 1955, were all made of twines of natural fibres, mainly cotton and hemp, which are known to have several disadvantages. They easily absorb moisture thus becoming heavy for fishing operation and being easy to friction are short in durability and are susceptible to decay by bacteria and fungi. Gear preservation treatment is, therefore, necessary to prolong their life. The fishermen have been employing different indigenous methods of preservation, such as coating them with a film of tannin by using the extracts of barks, fruits and seedcoats of various species of plants. The method of preparation of tannin extracts and treatment of the gear varies with locality. The indigenous method was improved, through research, by the tannin fixation method and subsequent coal tar treatment on tannin 'fixed' twines.

38.4.53 In the last twenty years, the twines of synthetic fibres have progressively replaced the natural fibres in the fabrication of nets, giving another trait to modernisation in the fishing industry. The synthetic fibres have several advantages over the natural fibres, besides having improved catching efficiency. In the first 7-8 years, the synthetic twines had to be imported and as such the change over had its limitations. After the indigenous manufacture of polyamide (nylon) fibre useful particularly for gillnets, and polyethylene and polypropylene twines for fabrication of parts of trawl nets and other bagnets, the requirements of the industry, including future expansion in fishing effort, would be adequately met with. Besides these, there are other synthetic fibres such as vinylons (polyvinyl alcohol and polyvinyl chloride) polyester and vinylidene (poly vinylidene chloride), which are being used in other countries. Of these, the latter two are of particular significance, because of their progressive use in fabrication of purse seine nets, having the requisite properties for fast sinking and maintenance of shape against currents.

38.4.54 The research on gear materials with reference to their relative properties and catching efficiency is being carried out in the CIFT. We recommend that the research on gear materials should be intensified, keeping in view the different types of synthetic materials, introduced in the industry all over the world for necessary improvements to be brought in all types of gear and for formulation of standards of different synthetic fibres.

38.4.55 Instrumentation and deck machinery: For improved functioning of fishing units, greater use in most of the countries is being made of instrumentation and deck machinery, developed for the shipping industry in general and some of the items for fishing industry in particular. The field of instrumentation includes the use of radars, direction finders and loran, wireless telephones, echosounder/fish finders—fixed type for larger fishing vessels and portable types for smaller fishing craft, sonar or all round ranging fish finders and various items of telemetering instruments. The deck machinery involves mainly labour saving devices such as vinches, Power blocks, gurdies, net and line haulers for the operation of different types of fishing gear. The working of the deck equipment has been rationalised, in the recent years, by the introduction of electrical or hydraulic machinery in replacement of mechanically operated equipment.

38.4.56 Of the aforementioned items, echosounders/fish finders, some of the telemetering instruments, and deck machinery for facilitating the operation of fishing gear would be of wider applicability in the modernisation of the fishing industry in India.

38.4.57 It has been observed that in whatever few fishing vessels echosounders/fish finders have been installed these are imported types. This is despite the fact that two electronic equipment manufacturers in India, one in public sector and the other in private sector, had brought out sample models which only needed improvements to suit the industry. There has been no further progress, and this item of equipment is still being imported. Considering that echosounders/fish finders constitute the most important item of instrumentation both for larger and smaller fishing units, it is suggested that CIFT should take up the matter with the firms to see that this item is manufactured in the country. In this context it would also be necessary to find out the possibility of the introduction of portable type of fish finders and demonstrate the advantages of the same, so as to create a demand to enable manufacturers to undertake fabricating this item on a commercial scale.

38.4.58 The CIFT has brought out certain items of telemetering appliances such as portable warpload and tension meters, speedmeter, underwater line tension meter, otterboard tilt meter and mesh distortion meter. But the operational advantages of these items have not been demonstrated to the industry, probably due to lack of necessary extension work. As regards items of deck equipment, trawl winches are being manufactured in the country, but the steps have not been taken for standardisation of this equipment through the Indian Standards Institution. It is encouraging to learn that one Indian firm has come forward to take up manufacture of hydraulic winches in consultation with the CIFT. This will be quite a step forward in the rationalisation of the operation of the gear. Except for trawl winches, no other deck machinery is being made use of in the industry to facilitate the operation of other fishing gear. We, therefore, suggest that economic advantages of different types of fishing devices should be demonstrated with a view to bringing about progressive modernisation in the operation of all types of fishing gear. The instruments and deck machinery required, and now manufactured in India should be standardised through the cooperation of the CIFT and ISI, keeping in view the need for reducing the number of items and their specifications, and the need for interchangeability of equipment.

5 TUNA FISHING IN THE HIGH SEAS

Fishing for Tuna in the Atlantic, Pacific and Indian Oceans

38.5.1 Tuna and the allied skipjack are oceanic fishes and as such exploitable mainly in the high seas of the Atlantic, Pacific and Indian oceans and around oceanic islands. Some of the wellknown forms are the white meat tuna or albacore, *Thunnus* (*Thunnus*) *alalunga* (Bonn.), the light meat tuna comprising yellowfin, *T.* (*Neothunnus*) *albacares* (Bonn.), Oriental bluefin, T. (*Thunnus*) *orientalis* (Tem. & Schl.), big eye, *T.* (*Parathunnus*) *obesus* (Tem. & Sch.) and the skipjack, *Katasuwonus pelamis* (Linn.). These are also the types which constitute the main bulk in the international tuna trade, mainly as frozen and canned products, and have increasing demand as prime fish in the affluent countries such as the USA, Japan and other European countries. In India, the tuna are not favoured much as table fish, except in the islands. The smaller tuna landed on the west coast fetch a low market price. The developments in the tuna fishing industry of the country would, therefore, mainly help in increasing the export of marine products.

38.5.2 The world catch of the oceanic tuna constitutes approximately two-thirds of the total catch comprising oceanic tuna, other tuna and allied fishes such as billfishes, king mackerels etc. The total catch had increased from 1.30 million tonnes in 1965 to 1.64 million tonnes in 1969 and remained around 1.60 million tonnes in the subsequent years. The following table gives the relative catches of the constituent types of the oceanic tuna, other tuna and allied fishes in 1971 :

TABLE 38.2

Landings of Oceanic Tuna, Other Tuna and Allied Fishes in the Three Oceans in 1971

('000 tonnes)

Item	Atlantic	Pacific	Indian	Total
oceanic tuna—				
(1) skipjack	36·0	294·0	0·1	330·1
(2) bluefin	38·4	42·4	27·7	108·5
(3) yellowfin	77·5	181·1	37·1	295·7
(4) albacore	77·3	128·9	12·5	218·7
(5) big eye	31·4	68·9	29·0	129·3
total .	260·6 (66·3%)*	715·3 (73·5%)	106·4 (44·0%)	1,082·3 (67·3%)
other tuna and allied fishes . .	132·7 (33·7%)	257·3 (26·5%)	135·3 (56·0%)	525·3 (32·7%)
total—oceanic tuna, other tuna and allied fishes.	393·3 (100·0)	972·6 (100·0)	241·7 (100·0)	1,607·0 (100·0)

* Figures in brackets indicate percentage of total catch.

It is seen from the table that the catch of the oceanic tuna in the Atlantic, Pacific and Indian oceans constituted 66.3, 73.5 and 44.0 per cent respectively whereas the other tuna and allied fishes together constituted the remaining percentage of 33.7, 26.5 and 56.0 respectively. The indicates that in the Atlantic and Pacific oceans, greater fishing effort is oriented towards oceanic tuna, whereas in the Indian ocean greater effort has so far been towards other tuna and allied fishes. Further, the catch of oceanic tuna in the Indian ocean is almost exclusively taken by Japan, Taiwan and Korea, and hardly any catch is being landed by the countries bordering on the Indian ocean, as indicated by the following statement :

Countrywise breakup of Catch of Oceanic Tuna in Indian Ocean

('000 tonnes)

	Skipjack	Bluefin	Yellowfin	Albacore	Big eye
Japan	0·1	27·7	14·7	4·4	12·5
Taiwan . . .	..	..	13·1	5·1	10·0
Korea	..	..	8·0	3·0	6·5
Maldives . . .	..	..	1·3	..	..
total . .	0·1	27·7	37·1	12·5	29·0

38.5.3 The fishing methods for oceanic tuna mainly comprise long lines for exploiting sub-surface fishery of adult tuna-albacore, yellowfin, bluefin and big eye. Live bait and pole and line method is used for exploiting the surface fishery comprising largely of skipjack and incidentally of small sized other oceanic tuna. The latter method is basically of two fisheries—first a fishery for live bait, on the success of which depends the fishery for tuna. It has been reported that considerable difficulties have often been experienced in this method in catching adequate quantities of live bait at proper times, even at the present level in exploiting surface fishery for tuna. But the introduction of field of fishing technology in the early sixties, of a single boat purse-seining with large and heavy nets, substituting the traditional two boat system, holds a promise in the world particularly for large scale exploitation of the surface fishery for skipjack, thus obviating the necessity of the precedent fishery for the live bait.

38.5.4 The fishing fleets of countries which have been largely exploiting the oceanic tuna, consist of large vessels, including factory ships, with modern navigational instrument, fish finders and processing equipment, particularly freezing on board. When the fishing fleets have to remain in the fishing regions for several months at a time because of the long distances from the home ports, the frozen stocks are transhipped to carrier vessels accompanying the tuna fishing fleets. Tuna fishing by smaller fishing vessels is also being undertaken in those regions where the oceanic tuna are available in appreciable quantities close to the shores.

Present Status in India

38.5.5 From the mainland of India, no fishing effort, exclusively for oceanic tuna is now being undertaken. These tuna merely constitute an incidental catch in the landings of other tuna and allied fishes, caught mainly by trolling lines and gillnetting. However, exploratory fishing for these tuna, by long lining, was conducted during the period of 18 months (September 1963 to February 1965), with the help of FAO expert, off the south west coast of India; the investigations showed that the catch composition, by weight, comprised 70 per cent sharks, 15 per cent tuna—mainly yellowfin and big eye, and 15 per cent spearfish and others. The only organised fishing for oceanic tuna, mainly skipjack, is being conducted in the near shore waters of the Lakshadweep islands. The fishermen in these islands undertake fishing by live bait and pole and line method which is being progressively undertaken from the mechanised boats since 1960, in addition to the fishing operations from the traditional craft. The quantity of oceanic tuna caught from these islands had risen from 130 tonnes in 1962 to 725 tonnes in 1971. The Administration incharge of the islands has set up a plant for canning tuna in the Minicoy, with a capacity of 10,000 cans per day. For want of adequate catch of tuna in the islands even during the fishing season of nearly 6 months, the present capacity is being considerably under-utilised.

Prospects for India

38.5.6 The stocks of different types of tuna which comprise the sub-surface fishery in the Indian ocean have been periodically assessed by the FAO, by analysing the data of the long lining operations conducted by Japan, Taiwan and Korea. It has been indicated that the stocks had more or less reached their respective maximum sustainable yield. This would mean that any additional fishing effort, either by the countries already exploiting the resourses or by the new entrants, would result either in the redistribution of the catch or in a very marginal increase in the total catch. Considering that this may be the status of exploitation of sub-surface fishery of tuna in the Indian ocean, even then India, as a new entrant, would have the important advantage of being much nearer to the resources than Japan, Taiwan or Korea, which have hitherto been largely exploiting the tuna in the Indian ocean.

38.5.7 With considerable prospects of increasing export earnings from the products of oceanic tuna, we recommend that India should make an early entry into the commercial fishing for high seas tuna in the Indian ocean. This would also enable India to have more effective participation in the international management of the high seas tuna resources in the Indian ocean.

38.5.8 As regards the resources for the surafce fishery, the FAO has estimated the Indian ocean has a potential of yielding skipjack between 200,000—400,000 tonnes per annum, as against the present exploitation of only about 25,000 tonnes. But unlike the sub-surface fishery which is already being commercially exploited, resources for the surface fishery in the Indian ocean for skipjack would need undertaking surveys for locating suitable fishing areas preferably with purse-seining operations. We recommend that the exploitation of skipjack fishery resources in the Indian ocean, particularly around the Indian islands should be given special attention in the development of high seas fishing for tuna.

38.5.9 It has been reported that the resources for sub-surface tuna fishery in all the three oceans have already been under heavy fishing pressure. As such the potential expansion for world-wide supplies of tuna seems to be limited. Besides, reported higher levels of mercury than the safe limits in some of the regions in the Pacific ocean have created quite a scarce in the tuna markets, thus adding to the problem of tuna supplies. The demand, on the other hand, is expected to grow much further. These situations are apt to result in the increase in the world tuna prices, which adds to the prospective features for India to enter into the fishing industry of oceanic tuna. But the economics of operating this industry, with very large capital investment on the fishing vessels and the high cost of fishing operations, would dictate the necessity of employing skill and expertise in the tuna fishing operations, so that such quantities of tuna are caught in the high seas as to keep the industry on the profitable side. To build up such an expertise indigenously, the proposition will have to be investigatory for quite a long time, besides involving huge expenditure. Since the commercial ventures could be started right away, knowing that the resources are already being exploited by other countries, we are of the view that process of developing expertise could be accelerated if foreign collaboration, having requisite expertise, were to be associated with interested sectors of Indian private industry or the proposed Marine Fisheries Development Organisation.

6 FISHERY HARBOURS

38.6.1 A full-fledged fishery harbour, comprises fish landing quay, berthing basin, an out fitting quay for replenishing fuel, water and other accessories required for fishing trips, a navigable approach at all tides and a slipway or dry dock for repairs. In addition, are needed ancillary industries for preserving and processing of fish. The character of a fishery harbour would, however, vary from place to place depending upon the present status of fisheries and further potentials for exploitation and the geographical and hydrographical features governing its location. Selection of the harbour site would also be dependent on aspects of marketing and trade in relation to consuming centres. At some places, the need may only be for providing minimum facilities for fish landing and berthing of boats. Whatever may be the nature of facilities required, these would constitute an important factor in the development of the marine fishing industry for proper functioning of fishing units and getting the right quantity and quality of fish landed for distribution as fresh fish or for processing. The capacity of fishery harbours created so far has been only for about 2,000 mechanised boats against nearly 12,000 boats introduced, which indicates the handicap the industry has been working with.

Planning and Execution of Harbours

38.6.2 The need for providing landing and berthing facilities for small mechanised fishing boats was first felt during the beginning of the Second Plan by which time the mechanisation programme had gained momentum. During the Second Plan period, the planning of fishery harbours was started with the assistance of FAO fishery harbour engineers. The places where some harbour facilities have, so far, been provided are listed in Col. (2) of Appendix 38.5. Besides, minor facilities such as landing jetties, sheds and guiding lights have been provided at a few other places.

38.6.3 Considering the fishery potential in deeper waters off the maritime States of India to be exploited with larger vessels, the Government of India envisaged the construction of larger fishery harbours in the areas of the major commercial ports. The investigations and formulation of the projects and the execution of these harbours were to be undertaken by the respective Port Trust Authorities. This phase of work started from 1965-66. As regards the construction of fishery harbours in other areas, it was felt by the Government of India that the maritime States were finding it difficult to conduct necessary investigations and to formulate plans and estimates. Accordingly, the Government of India and FAO as an executing and participating agency of UNDP, jointly set up Pre-Investment Survey of Fishing Harbours Project (PISFHP) at Bangalore in 1968 for preparing techno-economic project reports for full-fledged fishing harbours at different centres on both the east and west coasts. The maritime State Governments were left only with the planning of works pertaining to minor facilities, such as landing jetties, sheds and guiding lights. Thus, the works pertaining to planning and execution of fishery harbours and provision of landing, berthing and other minor facilities are being attended to by the following three agencies:

(i) planning and execution of minor works by the State Governments;

(ii) formulation of projects of fishery harbours outside the areas of commercial port by PISFHP and execution by the State Governments; and

(iii) formulation and execution of projects of fishery harbours within the areas of the commercial ports, by Port Trust Authorities.

38.6.4 Pattern of financial assistance: The schemes for providing harbour facilities were nonexistent during the First Plan. During the Second and Third Plans, these were treated State plan schemes. The Central assistance for state plan schemes was furnished under broad major heads of development, adjustments being permissible both between schemes under a major head and between major heads. Subsequent to the Third Plan period, the scheme of provision of landing and berthing facilities was brought under a centrally sponsored scheme, with an assistance of 50 per cent loan and 50 per cent grant for 1966-67, which was revised to 100 per cent grant for the next two annual plans and the entire Fourth Plan period. This pattern is continued for 7 essential components of a fishery harbour, viz., breakwater, wharf, jetty, dredging, slipway, auction hall, and internal road. The other facilities required to make harbour fully functional are to be provided by the State Governments.

38.6.5 Fishing harbours, large and small, are logical steps for industrial concentration of fishing, i.e., bringing about a change from the diffuse and scattered nature of the indigenous industry to concentration of modern methods of handling and marketing. In spite of the great importance of harbour development to marine fisheries, the pace at which the Centre and the States have progressed in this field has been very slow.

38.6.6 Minor works: There are nearly 1,800 fish landing centres on both the coasts. In most of the centres, the catch is still landed on the open beaches for further disposal. This is the most undesirable aspect of the industry. In the absence of necessary facilities of a jetty, the fishermen have to undergo considerable hardships, wading through slushy areas between the high and low water marks taking supplies for fishing trips and landing fish on return. There are no basic facilities for water supply, toilet etc. The importance of providing such basic facilities, were pointed out by various experts. The progress in the construction of these basic facilities, constituting minor works, has been quite unsatisfactory. Except in some of the States where some attention has been given to the construction of such minor works, Governments in other maritime States have not paid sufficient attention in providing such basic facilities. It is quite likely that either the State Port Departments or the Public Works Departments have not been able to render necessary assistance to the Fisheries Departments in planning and execution of these minor works. In this context it may be stated that the creation of engineering cells under the administrative control of Fisheries Directorates in the States, has already been suggested in the Chapter 37 on Inland Fisheries and Aquaculture; these would be able to undertake planning and execution of such minor works. We, therefore, recommend that for providing these facilities at landing sites in each maritime State, a comprehensive report on planning of minor harbour works should be prepared as expeditiously as possible. In undertaking the phased execution of these works after preparing necessary estimates at the appropriate time, the first priority consideration in providing funds should be given to the construction of essential works for giving an early relief to the industry.

38.6.7 Fishery harbours as per proposal of PISFHP: PISFHP had drawn up a tentative list of 90 sites for reconnaissance. While formulating the projects, the PISFHP took into consideration the priority of sites indicated by the State Governments, subject to satisfying the techno-economic feasibility. Since the establishment of this project, about 16 projects (Appendix 38.5) have been prepared at the average rate of 2 projects per annum. Four more projects are still to be finalised by this organisation. In all there would be about 20 projects at a total approximate cost of Rs. 40 crores at the current level of the cost of construction. As the component of expert services under the arrangement of International agencies would continue for a short time, it is considered that the project should continue with necessary strengthening of the staff to give the requisite technical cover for planning of fishery harbours.

38.6.8 Out of 16 projects which have been prepared and submitted to the Government of India, none has been taken up for execution; four have been recently sanctioned and the remaining are under consideration. It has been reported that only 1/3rd of the total provision made in the Fourth Plan was spent on this scheme. It can be stated, therefore, that the general progress in this scheme has been most disappointing.

38.6.9 The execution of the projects is undertaken by the State Governments. Excepting for the States of Gujarat, Maharashtra, Karnataka and Kerala, other maritime States have no separate organisation for the construction of ports. Even in the States where there is a port organisation, the fishery harbour works are generally entrusted to the Public Works Departments which do not have the necessary experience in the execution of harbour construction. It has also been felt that in cases where the harbour sites are in remote places along the coastline, these departments have not paid adequate attention. Fishery harbour works being small as compared with the commercial ports, some States have the problem of obtaining contractors to do the job. Further, the contractors are not willing to move to small and remote places, and take up fishery harbour works, unless they are heavily compensated. There have also been considerable delays of reconcilation of the estimates with the States. Some States have even gone to the extent of doubting the assumptions made in designing the projects. The States have also expressed that the rates followed by the project are not in conformity with the schedule of rates of the State Government It has been brought out that the project formulation should take up all necessary investigation such as drilling in rock, model tests, etc., before finalising the estimates and according sanctions to the proposals.

38.6.10 The PISFHP has so far been responsible for only formulating the projects of fishery harbours. It is, however, felt that the technical know-how required for the execution of works is equally important. Most of the harbour projects at present suffer for want of suitable organisation which would lend technical expertise and devote adequate attention to the task of executing the project with the time-bound programme. For these considerations it is desirable that the activities of the Project should be extended to the execution of the harbours. We, therefore, recommend that the scheme may be worked out by the Government of India in consultation with the State Governments so that the services of this Project could be made available to all the maritime States for speedy construction of fishery harbours, in addition to their taking up the most promising sites for survey and investigations. Further, the project reports in respect of 20 sites when finalised should be executed before embarking on any new sites.

38.6.11 Because of the physical characteristics of the Indian coastline, initial dredging work has to be undertaken at many of the harbour sites. It has been reported that the Port Trust Authorities and the Ministry of Shipping and Transport have limited number of dredgers and as such they would not be able to spare their equipment. The difficulties experienced by the States with regard to the dredging work could be well appreciated. On the other hand, it would not be economical for each State to go in for the necessary equipment. Making adequate provision for the execution of dredging works would, therefore, be an important item in the execution of fishery harbours. This would necessitate a centralised organisation which could work out the need of dredgers taking into consideration the existing and projected requirements and procure the necessary equipment. The agency has to be responsible for making available the necessary equipment to various harbours under construction. In view of the fact that the Project has been suggested to take up the responsibility of the execution work, we recommend that the same organisation should estimate the requirement of dredging work and procure necessary dredgers as a central pool for the construction of fishery harbours. By doing so, the PISFHP Project would be fully concerned with the planning, designing and execution of fishing harbours on a time-bound programme. Maintenance of these harbours will, however, be the responsibility of the State Governments.

38.6.12 It has been observed that the processing of the projects in the Government of India for according necessary sanctions takes nearly 2-3 years. This kind of delay obviously results in rise in the cost of estimates and a corresponding increase in the load of work in revising the estimates and obtaining fresh sanctions. We, therefore, recommend that the processing of projects in the Government of India should be streamlined so as to avoid undue delays.

38.6.13 It would also happen that the execution of several projects, which are being accumulated and processed in the Union Ministry of Agriculture and Irrigation, would have to be taken up in different plan periods, depending upon the funds available. Meanwhile, the estimates of work prepared at the time of formulating the projects, which may be several years in advance, would become out of date. This has to be avoided. Only those projects with uptodate estimates may be processed for sanction for which necessary funds would be made available for execution.

38.6.14 After the fishery harbours are commissioned, the responsibility of their management and proper maintenance would be that of the respective State Governments. The State Governments, have not devised suitable arrangements for undertaking this function. As funds would be required for maintaining the harbours no system has been organised for levying port dues and other charges. We, therefore, recommend that a suitable machinery be set up by the State Governments for proper management and maintenance of fishery harbours as well as for levy and collection of port dues and other charges.

38.6.15 Major harbours: The present status of the construction of major fishery harbours is given below:

Name of the Harbour	Capacity		Present position
	Large vessels	smaller vessels	
1. Bombay . .	65	465	(i) sanctioned in 1969 for Rs. 474 lakhs. (ii) estimates much below the tendered amounts Rs. 1,450 lakhs. (iii) proposal curtailed to Rs. 310 lakhs for provision of 250 small boats (revised proposal yet to be sanctioned by the Government of India. (iv) larger harbour to be planned at Agardanda.
2. Cochin . .	60	800	(i) sanctioned in 1971 for Rs. 273 lakhs. (ii) under construction but progress slow. (iii) difficulties in the initial stages in acquisition of land.
3. Madras . .	50	500	(i) sanctioned in 1968 for Rs. 388 lakhs. (ii) changes suggested. (iii) revised estimates of Rs. 568 lakhs sanctioned in 1973. (iv) work in hand—progress satisfactory.
4. Roychowk (Calcutta)	15	..	(i) sanctioned for Rs. 241 lakhs in 1974. (ii) construction in progress.
5. Visakhapatnam .	15	250	(i) sanctioned in February, 1975 for Rs. 324 lakhs. (ii) construction initiated.
6. Paradeep . .	15	50	project for Rs. 270 lakhs under examination.

सत्यमेव जयते

It would be seen that none of the major harbours has so far been completed. The projects in respect of first three harbours, i.e., at Bombay, Cochin and Madras, which were prepared by the respective Port Trust Authorities after taking 3-4 years in undertaking detailed survey, investigations and preparing plans and estimates were sanctioned by the Government of India during the period of 1968-71. The projects in respect of harbour at Roychowk (Calcutta) and Visakhapatnam were sanctioned only in 1974 and 1975 respectively, whereas the harbour project for Paradeep (Orissa) is still under the scrutiny in the Government of India.

38.6.16 It has been noticed that out of Fourth Plan provision of Rs. 1,350 lakhs for these harbours, only 10 per cent amount has been utilised. It has been reported that the large surrender is due to (a) non-availability of contractors to undertake the construction work at the estimated rates in respect of harbour at Sasoon Docks, Bombay; (b) the need for revising the project from certain technical aspects in respect of harbour at Madras; (c) slow progress of work because of difficulties experienced in acquisition of land in respect of harbour at Cochin; and (d) non-finalisation of the projects in the case of the remaining three harbours.

38.6.17 It is, therefore, suggested that following measures may be taken for expediting the construction of major fishery harbours :

(i) The State Governments and port trust authorities concerned should ensure that the required land would be available as soon as the project is cleared by the Government of India.

(ii) The port trust authorities should make a survey of the equipment locally so that when work is tendered there is enough response from the private organisations to undertake the work within the estimated rates.

(iii) Under the present procedure, it is required to obtain approval of the Government of India for sub-estimates contained within the original project estimate. Since examination of the sub-estimates by the Ministry of Shipping and Transport, Ministry of Agriculture and Irrigation and Ministry of Finance would take some time, it is felt that this procedure of obtaining prior approval of the Government of India, even though the project is administratively sanctioned should be dispensed with. The Chairman of the respective Port Trust Authority should be given full powers to invite tenders, select the contractor and execute the work without having to obtain approval of the Government. He may be permitted to do so provided the amount is maintained within the administrative approval of the project.

(iv) As a few larger fishing vessels have already been operating and some more would be introduced in the near future before fishery harbours are commissioned, the port trust authorities should provide the requisite facilities for them at commercial harbours.

(v) In the designing of major ports, provision has not been made for the construction of slipways and dry docks. The construction of dry docks may not be considered necessary as these facilities are already available at the commercial ports. The port trust authorities should, therefore, provide necessary facilities of dry docking in time for larger fishing vessels. However, provision of slipway should be considered as a necessity at each self-contained harbour.

Commissioning and Functioning of Harbours

38.6.18 Construction of a harbour is merely an initial step. The most important aspect is fully utilising its capacity which was envisaged in the report of the PISFHP and Major Fishery Harbour Projects to which the State Governments had given their endorsement. We recommend that the Centre and the State Governments should formulate expansion programmes of fishing effort from the prospective fishery harbours and then take necessary steps for fixing the bases of operations of newly introduced vessels from the fishing harbours as and when they are commissioned. Under the new pattern of assistance, the State Governments have to provide out of their funds, roads, processing plants, water supply, electricity, etc., required to make the harbour fully functional. Advance planning in this direction is very important so that provision of these facilities are synchronised with the completion of harbour construction by the Central Government.

38.6.19 All project reports prepared by the PISFHP or the Port Trust Authorities are required to be technically scrutinised by a competent organisation before recommending for financial sanctions. As per the present system, projects relating to major fishery harbours are being scrutinised by the Ministry of Agriculture and Irrigation under the technical cover given by the Ports Organisation in the Ministry of Shipping and Transport. Scrutiny of the remaining projects is entirely the responsibility of the Ministry of Agriculture and Irrigation. This procedure may be continued in the interest of taking as little time as required for processing the reports.

7 TRAINING OF OPERATIVES

38.7.1 In the absence of any vocational training facilities in India in marine fishing technology the system of 'on-the-job' training in the traditional fishing techniques was, prior to Independence, the only course left to the fishermen to pass on their long acquired experience to the younger generation. The initial development of mechanising the sailing craft and introduction of bottom-trawling conducted from small mechanised boats, and also the need for introduction of larger fishing vessels and new fishing methods created the need for training facilities. This was essential for increasing per unit productivity as a cover against the risk of heaviour investment of capital in the industry and to turn out qualified people for manning mechanised fishing boats as prescribed by statutory provisions for their operation. In pursuance of these needs, the maritime State Governments/ Union Territories organised Fishermen Training Centres and the Union Department of Agriculture established in 1963 the Central Institute of Fisheries Operatives (CIFO), Cochin (Kerala), as per the recommendations of the Committee on Fisheries Education[1] (1959). It may also be of no less significance that the training facilities attract younger folk of the fishermen communities so that they could remain as skilled operatives in their own profession, rather than seek opportunities for other jobs because of low income, inherent handicaps and hardships in the traditional fishing methods.

Training Operatives for Small Mechanised Fishing Boats

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38.7.2 As an initial step in properly organising the fishermen training centres in the States, the Government of India obtained the services of FAO experts in fisheries training, firstly for conducting a training course in 1954 for those who were eventually to be teachers at the training centres, and subsequently for establishing a few centres in some of the States. There are at present 27 training centres in the maritime States and Union Territories with a total intake capacity of about 800 trainees at a time. The conditions for entry are that the candidates should be between 17 and 30 years of age, and that they should be bonafide fishermen with atleast 5 years experience in fishing. The duration of the course is of variable periods ranging from six to ten months. The training is mainly given in the fields of navigation, working of internal combustion engines, materials and construction of fishing gears, fishing methods and their operation. This training is imparted for operating the small mechanised fishing boats. The successful trainees, in groups of four or five, are then given necessary assistance in acquiring small mechanised boats, with loan and subsidy arrangements, with a view to affording them an opportunity of self-employment. About 7,000 candidates have passed this course.

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[1] Panikkar, N.K. et. al., 1959. Report of the Committee on Fisheries Education : 1-144 New Delhi. Ministry of Food and Agriculture Government of India.

38.7.3 The mechanised fishing vessels, which do not exceed 15 tons net or 25 tons gross, do not come within the purview of Indian Merchant Shipping Act, 1958. These vessels are, therefore, registered either under the Coasting Vessels Act of 1938 as in Maharashtra or as per Harbour Craft Rules framed under the Indian Ports Act (XV of 1908) for different ports in other States. As the registration under the Harbour Crafts Rules entitles the operations within the harbour limits, the operators of small mechanised fishing vessels are often put to considerable difficulties for fishing outside the harbour. Besides, there are no rules, statutory or otherwise, with reference to crew for manning them. The port authorities do not recognise the certificate issued by the State Directorates of Fisheries or CIFO.

38.7.4 We recommmend that necessary rules for uniform application in all the maritime States, with reference to navigation, registration and manning of vessels of 25 tons in gross or below, should be expeditiously framed by the Director General of Shipping, taking into consideration the specific conditions of the fishing industry, including the recognition of the certificates issued by the State Directorates of Fisheries or CIFO as the necessary Competency Certificates for operating such vessels outside the harbour limits. In this context it would be necessary that the training imparted at the Fishermen Training Centres in different States should be based on a standard pattern of syllabus, equal duration, and uniform rules for testing proficiency. It is further recommended that the uniform pattern of syllabus and examination rules for awarding the certificate should be framed jointly by the fisheries organisations of the maritime States and the Centre, in consultation with the Director General of Shipping.

38.7.5 The Fishermen Training Centres have hardly touched upon any activity in relation to the working fishermen and their traditional fishing methods. Difficulties in organising such activities could be envisaged in the initial stages. The fishermen all over the world, by and large, have a complex of having acquired expert knowledge on their own. They generally do not show response to any activity in the initial stages even to supplement their knowledge for improving their working systems. These difficulties have been overcome in several parts of the world by organising meetings and discussions amongst the fishermen in the non-fishing season, in which the fishermen experts in their respective lines can disseminate knowledge to their own brethern. Such a step has been of help in building up necessary initial liaison to be followed with other steps of building up an extension service including arranging short-term training for marine fishermen. We recommend that the fisheries organisations in the States should take necessary steps to enable fishermen training centres to assume additional function of developing necessary liaison and building up extension service amongst the working fishermen in the region with a view to improving their working systems.

Training of Operatives for Manning of Larger Fishing Vessels and of Shore Technicians

38.7.6 The Central Institute of Fisheries Operatives was established in 1963. The Institute offers training courses in seven disciplines—fishing secondhand, engine driver, radio telephone operator, gear technician, boat-building foremen, shore mechanic and training teachers. For increasing the capacity of training, a unit of the Institute was established at Madras in 1968. The intake capacity in different courses, their respective durations and percentage utilisation, are given in Appendix 38.6. It can be seen from the Appendix that the utilisation in the three training courses, fishing second hand, engine driver and radio telephone operator, constituting together as personnel required for manning larger fishing vessels, has been more than 70 per cent. The utilisation of the capacity in the three courses has been only between 30 and 50 per cent, whereas the facilities created at the Institute for teachers' training courses with the utilisation percentage below 25 has indicated that this training course is very poorly patronised by the States in deputing candidates.

38.7.7 Manning regulations : As per the Indian Merchants Shipping Act, 1958, Rule 76(4), regulations with reference to manning of larger fishing vessels are given below :

(i) fishing vessels exceeding 25 tons gross but not exceeding 50 tons gross..............one certificated Skipper;

(ii) vessels exceeding 50 tons gross..............one certificated Skipper and one certificated Fishing Secondhand ;

(iii) vessels of 50 Nominal Horse Power (= 282 BHP) and above ....one certificated Engineer; and

(iv) vessels less than 50 Nominal Horse Power.................one certificated Engineer or one certificated Engine Driver.

38.7.8 From the aforementioned regulations, it is clear that for operating larger fishing vessels, four categories of personnel i.e., skippers, fishing secondhands, engineers and engine drivers would be required who should be holding Competency Certificates after appearing for respective examinations held by the Mercantile Marine Department under the respective examination rules. These examination rules give various alternative qualifications with corresponding sea-time/

workshop time prescribed for each qualification as a condition precedent to appearing for Competency Certificate examinations. The qualifying sea-time/workshop time, as applicable to the institutional candidates after passing out their courses to appear in Competency Certificates of fishing secondhand or engine driver in the first instance, and subsequently to gain further qualifying sea-time to appear for the Competency Certificate examination of skippers and engineers are as follows:

fishing secondhand

(i) 36 months on deck on board of sea-going fishing vessels of not less than 25 tons gross;
(ii) 42 months at sea on deck, of which 12 months must have been on board of sea-going fishing vessel of not less than 25 tons gross;

engine driver

18 months workshop service and 9 months sea service in the engine room of a fishing vessel fitted with an engine of not less than 40 BHP.

skipper

60 months service at sea of which atleast 12 months must have been as a certificated fishing secondhand on board the sea-going vessel of not less than 25 tons gross.

engineer

Certificated engine driver with 21 months of sea service in the engine room of a fishing vessel fitted with not less than 170 BHP.

38.7.9 Considering the prescribed qualifying sea-time for fishing secondhands and the present availability of berths in a limited number of vessels above 25 tons gross, the institute has been experiencing considerable difficulties in providing necessary qualifying sea-time to the trainees who have passed the institutional training course in this discipline. The Mercantile Marine Department has been granting a remission of 9 months in the seatime in the case of institutional trainees. Similarly, this Department has also been granting remissions of 12 months in workshop time in case of institutional trainees appearing for Competency Certificate examination of engine drivers. These concessions are being granted as a matter of discretion and not as a part of examination rules. We, therefore, recommend that the grant of remissions in the sea-time/workshop time, being given as a matter of discretion by the Mercantile Marine Department, should constitute a part of the examination rules.

38.7.10 We also recommend that all the rules and regulations pertaining to registration, navigation, manning and examination with reference to fishing vessels should constitute as a separate Chapter in the Indian Merchant Shipping Act and a separate booklet be brought out for the use and guidance of the fishing industry.

38.7.11 Proficiency test in fishing: The candidates for the Competency Certificate of fishing secondhands and skippers are, at present, examined by the Mercantile Marine Department only in the discipline of navigation and seamanship which constitutes only a part of the job requirement. They are at present not tested in the fishing proficiency which would constitute the most important aspect of the job requirement of skippers and fishing secondhands. We, therefore, recommend that the candidates for fishing secondhands and skippers should first be tested in fishing proficiency before they are entitled to appear for the examination of respective Competency Certificates. For this purpose, the Ministry of Agriculture and Irrigation should be made the proper authority for grant of Proficiency Certificate in fishing as a condition precedent to appearing for respective Competency Certificate examination held by the Mercantile Marine Department.

38.7.12 Change in the mode of training: Out of about 400 candidates trained as fishing secondhand, only 19 have qualified as certificated skippers and 66 as certificated fishing secondhands. Similarly, out of nearly 360 trainees who have passed institutional course as engine drivers, only four have so far, become certificated. This gives an approximate indication of trained candidates not being able to gain necessary qualifying sea-time/workshop time after completing the institutional training. This is a considerable wastage in the training effort causing a handicap in getting eventually qualified personnel. This is due to the inadequacy of affording necessary facilities to the trainees after completion of their course. We, therefore, recommend that the present system of institutional training should be modified in such a way that the candidates gain qualifying sea-time/workshop time in between the institutional training, so that they can directly appear for Competency Certificates.

38.7.13 Availability of skippers: The Ministry of Agriculture and Irrigation had envisaged the introduction of 300 larger fishing vessels during the Fourth Plan. In terms of personnel requirements as per regulations, there would have been a need of 300 skippers, if each of these vessels were to be of 25 tons gross and above, and an additional demand of Certificated fishing secondhands in proportion to the number of vessels exceeding 50 tons gross each. The magnitude of the problem then could be realised in the context of only 19 available skippers who have so far qualified after going through the institutional training. It was coincidental that the problem did not arise as the progress in this scheme was very insignificant. The Ministry has been following the programme of development of marine fisheries, by way of introduction of larger fishing vessels without any due consideration to the availability of skippers which would, therefore, raise relevant problems. Planning for integrated development in this sector of marine fishing industry should take into consideration the important factor of availability of skippers. Considering a minimum integrated development programme of utilising 75 per cent of the institutional capacity with reference to fishing secondhands and 50 percent of the candidates, after a number of drop-outs, qualifying further for skippers' Competency Certificates, it may be reasonable to assume that 30 skippers would be available every year. This would mean a minimum programme of introduction of 30 fishing vessels each of 25 tons gross and above per annum or 750 vessels in the next 25 years. As it takes at least five years for skippers to qualify, it would be necessary to formulate developmental plans for the introduction of larger fishing vessels in advance so that there should be no difficulty of availability of skippers. On the other hand, there may be possibility of more skippers being available than the industry, either in the public or private sector, could absorb. In such an event the trained personnel will have to be encouraged by offering them necessary incentives for self-employment, as is being done in the case of trained fishermen by enabling them to acquire small mechanised fishing boats. The Institute should maintain necessary records of the trainees who qualify for different Competency Certificates and render necessary counselling service to the qualified personnel for employment in the industry.

38.7.14 Radio telephone operator : As per the existing rules for operation of radio telephone equipment, the skipper who is the operator in the case of fishing vessels, should have the appropriate certificate of proficiency to handle the equipment. It would, therefore, be advisable to include the training in respect of working of this equipment in the syllabus for the fishing secondhands and the trainees should be directed to appear for necessary proficiency certificate examination, conducted by the Ministry of Communication so that they could be eligible to operate the radio telephone equipment.

38.7.15 Shore technicians : The utilisation of the intake capacity in the three courses for shore technicians has been between 30 and 50 per cent. The Ministry of Agriculture and Irrigation should take appropriate steps to justify the continuance of these courses with better utilisation.

38.7.16 Teacher training course : The utilisation of the capacity for this course has been below 25 per cent. This facility has been created for updating the knowledge of the teachers of the States fishermen training centres, so as to improve the quality of teaching in these centres. It has been reported that some of the States have not deputed even a single teacher. It is considered that the authorities in the States should encourage the deputation of teachers for this course in the interest of making fishermen training centres more efficient.

8 ECONOMIC ASPECTS

Lack of Economic Studies

38.8.1 The basic structure of economic organisation in the marine fishing industry of India, at the production level, comprises mainly non-mechanised fishing craft numbering about 120,000 units. These yield an approximate fish catch of 0.72 million tonnes per annum, with an average per unit yield of about 6 tonnes. In addition, there are about 11,000 mechanised fishing units in operation, giving a production of about 0.33 million tonnes, with an average of 30 tonnes per unit. The industry at this level is worked by about 0.65 million marine fishermen out of a total of about 1.0 million marine fishermen in the country, the remaining 0.35 million fishermen working in the subsistence fisheries without any craft in the inter-tidal waters with small fishing gear. Considering the estimated production at this level of about 1.0 million tonnes per annum, the average per capita output is about 1.5 tonnes per annum. In terms of money, this quantity, except in certain places where the prime quality constituents of the catch form a substantial proportion, would not fetch more than Rs. 1,500. From this amount, the producer has to meet annual expenditure on his fishing unit, leaving a balance of about Rs. 1,000 to Rs. 1,250 for a family of 5 persons, i.e., per capita income of about Rs. 200 to Rs. 250 per annum. This level of income would, therefore, indicate that the community of marine fishermen has been working at a sub-economic level considering that the national desirable minimum level of consumption has been reckoned at Rs. 2,200 per family of 5 persons, at 1971-72 price level.

38.8.2 There have hardly been any studies undertaken on the comparative economics of different types of fishing methods, on economic status of the fishermen in different productive sectors of the industry, and on the economic impact on fishermen by changes in the industry, particularly the introduction of mechanised fishing. The only detailed study[1] undertaken so far, is based on the assumption that different types of production methods such as trawling, gillnetting, boat-seining, shore seining etc. have similar economic characteristics, whereas, in actuality, the cost and return functions in terms of quality and quantity of catch would considerably vary. For example, trawling can only be conducted from a mechanised fishing boat, whereas the gillnetting operation could be undertaken from either a mechanised or non-mechanised craft, in which case the respective economic determinants vary in magnitude. The important inference reported in this study has been that a unit investment of Rs. 100 on a non-mechanised craft can yield a gross catch four times higher and more than two times in value of the catch obtained by mechanised fishing. This has been based on the average catch of 17.7 tonnes per non-mechanised fishing craft, taking 67 units out of about 120,000 total craft in India representing only sample size of 0.06 per cent. However, the average catch of 29.4 tonnes per mechanised fishing boat is based on a sample size of 382 units out of the total of 6,515 such units then in operation, representing sample size of as much as 6.0 per cent. The average catch of the mechanised boat seems to be well in accordance with the general average for the whole country, but the average catch of a non-mechanised boat seems to be three times the average catch of about 6.0 tonnes per unit for the country as a whole. If the average catch were to be taken at about 18.0 tonnes for a country craft as per that study, the production from the fleet of non-mechanised craft alone would work out to be about 2-16 million tonnes which would be twice the total present production. It would, therefore, seem that the deductions drawn on the comparative economic performance of the mechanised and non-mechanised fishing craft would not hold any reasonable applicability. The study has, however, drawn an important attention to the scope of improving economic performance of mechanised fishing boats by as much as 25 per cent by maintaining a minimum schedule of 225 fishing days as against the present average of only 170 days.

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[1] 1971. Report on the Evaluation of the Programme of Mechanisation of Fishing Boats: 1-110-2. New Delhi. Planning Commission, Government of India.

38.8.3 In the absence of studies on the cost and return functions in different fishing methods and on the economic status of the fishermen in different maritime States, we recommend that the necessary studies should be jointly undertaken by the States fisheries organisations and bureaus of economics and statistics for subsequent review at the Centre for planning developmental programmes and determining their economic impact.

Marine Fisheries Cooperatives

38.8.4 The introduction of mechanised fishing fleet constituted the main factor in the economic development of the marine fishing industry for increasing production. The programme was initiated during the First Plan and gained rapid strides in the subsequent Plans.

resulting in the introduction of nearly 12,000 mechanised fishing boats. Considering the economic backwardness of the marine fishermen and the nature of modernisation in the industry as capital intensive, the necessary financial assistance was extended in furtherance of the programme. In the initial stages, the programme was financed entirely by the government, giving 100 per cent assistance in the form of loans and subsidies for the acquisition of mechanised boats, taking such units as the only security. Besides, subsidies of varying percentages were given on the gear materials, particularly in promoting the increasing use of synthetic fibres, and for other requisites such as winches, gurdies, high speed diesel (HSD) oil etc. As the pace of mechanisation increased, the quantum of subsidies was gradually scaled down.

38.8.5 The attempt at developing the marine fishing industry through the agency of fisheries cooperatives has not met with any significant success. An idea of the performance of the marine fisheries cooperatives which have been set up can be had from the Table 38.3.

TABLE 38.3

Performance of Primary Fisheries Cooperatives in the Maritime States

	Number of primary fisheries societies	Societies showing profit	Societies showing loss	Societies with no profit no loss	Percentage societies showing profit
Andhra Pradesh	597	114	363	120	19·1
Gujarat	59	25	27	7	42·4
Kerala	985	130	780	75	13·2
Maharashtra	381	181	156	44	47·5
Karnataka	121	74	30	17	61·2
Orissa	154	48	63	43	31·2
Tamil Nadu	448	169	270	9	37·7
Goa, Daman & Diu	11	4	7	..	36·2
Lakshadweep	3	3	..	..	100·0
Total	2,759	748	1,696	315	27·1

The number of societies showing profit constituted only 27 per cent of the total societies set up, whereas the number of societies showing loss was as high as 61.5 per cent. A more precise idea of their performance can be had on the basis of the magnitude of profits shown or losses incurred by the different societies. However, it is apparent that the number of viable societies was not very large especially in States like Kerala and Andhra Pradesh where the percentage of societies showing profit was less than 20. However, in the States of Orisa, Maharashtra and Gujarat as also in Goa, Daman and Diu, the percentage of societies showing profit ranged from 30 to 50 and in Karnataka this percentage was 60.

38.8.6 The large number of nonviable societies indicates that the cooperative system has failed to develop viable volume of business. The failure of the cooperatives is also ascribed to several other reasons like vested interests of influential members, rising overdues and poor management. Many copoeratives were only in the nature of credit societies and even then could not meet the credit requirements of fishermen on time or in adequate measure on account of their poor resource position consequent upon inadequate financial accommodation from the cooperative banks or from government sources.

38.8.7 The failure of the cooperative societies in serving the needs of the fishing communities, even in spite of their proliferation in number is, however, not a characteristic feature of the fisheries sector alone. Similar problems of cooperative development have been felt in other sectors of the agricultural economy. We are of the view that the cooperatives along with other institutional financing agencies have played their role well in the adoption of new technology by relatively well-placed and influential section of the farming community*. If the small and marginal sections of the fishermen community are to be actively involved in a comprehensive organisation for planning their production both on collective and individual basis, a new type of cooperative society would have to be organised. This society should provide an integrated credit service to facilitate the conversion of credit into inputs and services as well as realisation of a fair price for the produce. We have suggested a suitable organisation for this purpose, viz., a Farmer's Service Society in Section 3 of Chapter 55 on Credit and Incentives. We recommend that the feasibility of trying this structure in the sphere of marine fishing industry should be examined by the concerned States. To begin with, each maritime State should set up two or three societies on a pilot basis in areas where the fishing community operates primarily as small units of production. We are of the view that unless the fisheries cooperatives are organised on these lines, whatever organisational or financial assistance is rendered by the government under various schemes is likely to get diluted and lost in the existing cooperative structure. It has to be realised that cooperative societies cannot function as viable units merely by distributing loans and subsidies given by the government or dispensing credit. For attaining the objectives of economic efficiency and performing the role expected of them in the development of the industry, they have to provide a complete package of services, from supply of credit through supply of inputs and extension services to marketing and processing.

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*vide Chapter 55-Credrit and Incentives.

38.8.8 We would also recommend that the maritime States should undertake a comprehensive study of the existing marine fisheries cooperatives with a view to assessing the type of assistance needed, managerial or financial, to bolster the uneconomic units and make them viable. It is suggested that the feasibility of reorganising the nonviable units on the lines of the Farmers Service Societies suggested by the Commission should be examined.

38.8.9 There is yet another important function which the cooperatives in the marine fishing areas have to perform with reference to the consumption loans required by the fishermen members. It is commonly known that during the cessation of fishing activity during monsoon, the fishermen take consumption loans from the middlemen mainly because they have not yet cultivated the habit of saving even when the fishing seasons are exceptionally good. The marine fisheries cooperative societies have, therefore, to promote this habit by apportioning certain percentage from the sales of their produce towards compulsory saving in their accounts. As such, it is suggested that the societies should perform the additional function of mobilising savings considered necessary for consumption by fishermen during the period of monsoon so as to save them from exploitation by the middlemen.

Institutional Financing

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38.8.10 Till the end of the Third Plan, practically all developmental schemes were mainly financed through the outlays provided in the Government sector, and the only institutional finance available to the industry was from the cooperative banks to the cooperative societies. The approach adopted by the Government, at the beginning of the Fourth Plan, was to transfer the liability for meeting loan requirements from plan schemes to other financial institutions such as Agricultural Refinance & Development Corporation (ARC), Agricultural Finance Corporation (AFC), and commercial banks. This step gave orientation in formulating integrated projects covering catch to marketing fish. These projects were examined from the point of view of techno-economic feasibility by these institutions as bankable propositions before sanctioning necessary loans. Besides, small schemes were also cosidered for sanctioning loans such as purchase of mechanised boats etc. The ARC provided refinancing facilities for giving medium and long term loans to the fishermen cooperative societies through the cooperative banks and to the private entrepreneurs by refinance through the commercial banks. The commercial banks started advancing medium and short term loans directly and through AFC. But the conditions for grant of loans were such that they favoured mainly the private entrepreneurs but these were beyond the capacity of the fishermen. In the initial few years, the extension of credit facilities by these financial institutions to the industry received an unexpected stimulus through substantial loaning. This phase was, however, shortlived as there were considerable accumulated overdues, particularly during the lean years of production. It has resulted in the adoption of more cautious attitude by these financial institutions, and it seems very unlikely that the economic characteristics inherent in the nature of the industry would be able to sustain such credit system.

Economics of Mechanised Fishing

38.8.11 In considering the economics of mechanised fishing units, which are known to be capital intensive, the first liability is to meet the annual cost functions. These comprise the cost of capital such as annual repayment of capital in 10 equal instalments, average interest on it at 10.0 per cent, and annual depreciation at the rate of 10 per cent. Further, the operational cost including items such as crew wages, fuel and lubricating oil, insurance, maintenance and repairs etc., have also to be paid for. All these costs have to be met from the return functions in terms of quantity and quality of catch and the value thereof to arrive at the balance, which would determine the economic profitability. The return functions are known to vary considerably, not only for different sizes of vessels but also for the same size of vessel from the same base of operation but undertaking different types of fishing methods. They also vary for the same size of vessel adopting similar methods of fishing but undertaken from different bases of operation. Besides, the return functions in terms of value for the same quantity and quality of catch would vary in relation to difference in prices prevailing at different landing centres. Under the circumstances, it becomes difficult to present a general picture of the economics of fishing units in marine fishing industry. However, the cost functions of the same size of the fishing vessel would show minor variations, mostly on the items of expenditure on HSD oil because of variable distances, due to different extent of continental shelf, to reach the same depth of water. They also vary with the cost of different types of gear for undertaking different types of fishing methods. By taking the annual cost functions of different sizes of vessels in the range of 9.7—17.4 m from various reports, the obligation to meet the cost functions in terms of total quantity of catch on the basis of different series of prices and proportions of high, medium and low unit value items have been worked out (Appendix 38.7) as below:

$$L = [pc_1 + qc_2 + rc_3]\ X$$

$$\text{or } X = \frac{L}{pc_1 + qc_2 + rc_3}$$

where L is the total annual expenditure as cost function. X is the total catch to offset the cost function, c_1, c_2 and c_3 are the respective prices realised by the producer for high, medium and low unit value items of catch, and p, q and r are the respective proportions of these three types of items in the total quantity of the catch.

38.8.12 The case study takes into consideration the reasonable prices of different units value items as tenable in 1973, such as prawns of exportable quality as the high unit value item at Rs. 10,000 per tonne, pomfrets, *rawas, dara, surmai, ghol* etc., at Rs. 2,500 per tonne constituting medium unit value item, and the remaining types of fishes such as sardines, mackeral, lesser sciaenids, ribbon fishes etc., as low unit value item at Rs. 500 per tonne. Besides these three items, it would also be necessary to consider a forth item of still lower price of Rs. 250 per tonne. This item is considered in the event of the necessity of using low unit value catch as raw material for reduction into fishmeal because of its inacceptability as food fish, or due to difficulties in its disposal. The fourth item is also accounted for when the lesser varieties of fishes are required to be processed, as a better economy measure on-board the larger fishing vessels by providing 'pocket size' fish meal plants. Such plants are being installed in other countries for utilising the trash fish instead of throwing them over-board.

38.8.13 It may be stated that only five typcial examples have been worked under the general formula, which would indicate the broad scope of different quality-combinations of catch obtained by main commercial types of fishing methods but these do not claim to be standard for all applications which otherwise would be too numerous. Inevitably, the economic profitability in these examples would be the respective quantities of catches over and above the obligatory catch to meet the cost functions.

38.8.14 The most important aspect in the economic considerations of marine fishing is the very initial step in avoiding the induction of more capital in the industry, than is essential, by introducing larger or costlier fishing vessels. More economical vessels—smaller in size or less costly, can be introduced without compromising the potency of the fishing units. For example, it would be unwise to use vessels of 17.4 m the way they have been fabricated, and economically overload the industry, when a wooden vessel of 14.9 or 3.1 m has been reported to work satisfactorily in the similar range of operations. It is also interesting to note that even a small vessel of FRP, 9.9 m in length which costs only 1/6th in capital and annual operational charges than a steel vessel, can also operate in the depth range upto 80 m for which range 17.4 m steel vessels were fabricated. It has been stated that the Government of India gives subsidy of about 27½ per cent on the indigenous construction of fishing vessels of only steel vessels larger than 17.4 m. There seems to be no justification in continuing to restrict subsidy only on such conditions and invite investment of more capital than is required. We recommend that the Government of India should suitably modify the grant of subsidy scheme so as to cover fishing vessels of all types of material and of adequate size to undertake fishing in offshore waters with a minimum endurance capacity of remaining at sea for more than 72 hours.

38.8.15 The industry, in the last 20 years, made the maximum progress in the sector of catching and processing prawns, mainly for export to the high-priced markets of the world, which provided the necessary economic stimulus. At the production level, this sector of the industry is mainly supported by a large fleet of small trawlers mostly up to 11 m in length two of which have been exampiified in the Appendix 38.7 vide examples (b) and (c). It would be seen that the economics of the operation of these trawlers have the minimum obligation in terms of the quantity of catch, indicating therefore comparatively higher potential of profits. Another example, which is equally comparable in the terms of these obligations is given at (e) representing the gillnetting for prime fishes. Most of the mechanised boats in the country are operating mainly in these two types of fishing in addition to mechanised boats in Gujarat and Maharashtra for undertaking *dol* net fishing. In respect of percentage of profitability over the investment, it has been reported[1] that mechanised boats upto 11 m in length accounted for an all India average rate of return or economic profitability of 14 per cent during the years 1968-69. This would be a reasonable index of profitability in the industry for investments if this were to constitute an average rate of return spread over a number of years covering both good and lean seasons of fishing. There has been no economic study undertaken on such an average rate of return in the industry. It would, however, be natural to except that such a rate of return would be subject to considerable variations depending upon the fishing seasons. In the circumstances of two or three continuous lean years the borrowers may find it beyond their capacity to make repayments of loan instalments and interest. Such overdues have already been experienced by the financial institutions as already stated, even in the most highly profitable sector of marine fishery production. The situation would be further unrewarding for utilising the present system of credit facilities offered by the financial institutions in other sectors of production in the industry. This would be specially so for the exploitation of resources in deeper waters with costlier fishing units which may be productive in terms of quantity, but may be comparatively still below the economical level of operation because of low prices fetched by such types of fishes in the domestic markets.

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[1] Sachidanandam, A., 1972 Are our mechanised fishing boats viable ? Seafood Exy. j. 4 (1) : 1—14

Incentive Support

38.8.16 The marine fishing industry at the production level, all the world over, is characterised by the inherent economic uncertainty because of high degree of risk involved in it and high investment structure in proportion to its economic profitability. In view of these economic characteristics, the marine fishing industry is given incentive support in almost all the countries, both developed and developing. This support is provided in a variety of forms through specialised organisations such as fisheries banks, fish development authorities, fisheries boards, marine fisheries services etc. These organisations provide varied percentages of subsidies, preferential loans on long term basis extending even up to 15 years or so, and even giving relief by way of different patterns of tax exemptions. In countries lacking such specialised organisations, the adequate flow of credit to the fishing industry is ensured through financial institutions by giving subsidies on the rate of interest and undertaking guarantee of loans by the governments. It may be emphasised that these countries have considered it necessary to give the incentive support to the industry on the basis of economic analysis of fisheries which have attained an advanced stage.

38.8.17 These incentive steps have assumed considerable importance in many countries for developing maximum efficiency in the harvesting sectors of their national marine fishing industries in not only maintaining production but also for increasing production from the international waters. It also illustrates the advantage of putting the resources to the maximum economic utilisation, involving an input of increasing fishing effort, without any gestation period on investment, as fishing units start giving returns soon after they are commissioned.

38.8.18 In expanding marine fish production in India by extending the range of exploitation to deeper waters, the yield, as already stated, would be proportionately much larger in quantities of low unit value items than in the coastal fisheries. Economically, this constitutes a great handicap in the initial stages of development of this sector, till the products become popular and remunerative in the domestic markets, as most of the yield will have to be consumed in the country, except of course some of the exportable quality fish like high seas tuna. We are, therefore, of the view that there is a need for giving a reasonable incentive support to the industry in developing offshore fisheries, which should not be linked with export performance.

38.8.19 While considering the incentive support, it may first be necessary to formulate some idea about the quantum of capital requirements as an investment on acquisition of fishing vessels in the next 25 years. It has been envisaged that the production could be increased from the present level of about 1.0 million tonnes to reach at least 3.5 million tonnes after 25 years, with an annual compound growth rate of 5.2 per cent. Considering the cost structure of fishing vessels in 1973 and the obligatory catch in terms of meeting the cost functions, it may reasonably be assumed that the capital investment of about Rs. 20 crores would be necessary for producing 100,000 tonnes per annum. The total demand for the first ten years to produce additional 1.0 million tonnes would be about Rs. 200 crores, and Rs. 500 crores for 25 years. However, by creating an arrangement of a system of rolling fund in the investment structure on the acquisition of fishing vessels i.e., by recirculating the amount at assumed preferential interest at 5.0 per cent of rolling funds returned as loan instalments given through an appropriate agency, the total requirements in the first ten years would only be of the order of Rs. 155 crores.

38.8.20 The present system of incentive support given by the Government of India in the form of mere subsidy for the acquisition of indigenous vessels for the exploitation of offshore fisheries has not been effective because of lack of suitable support given by the government for obtaining the necessary loans such as subsidised rate of interest, guarantees etc. In consideration of this, we recommend the grant of preferential loans with grace periods of low interest to accelerate the development in the initial stages. This financial assistance under these circumstances would come from the government as rolling funds to be given as preferential loans to be channelised through the public sector fisheries corporations in the States in case of fishing vessels upto 25 GRT and through Marine Products Export Development Authority in case of vessels above 25 GRT. These would serve as specialised fisheries agencies for financial assistance to look after the specific interests of the industry and grant remissions in the periods of instalments in case of necessity, give credit on long terms basis and other easy terms with reference to securities, making arrangements for deferred payments in acquisition of vessels etc.

38.8.21 Another important aspect which needs consideration as an incentive Support is the extension of the present scheme of the Government of India on duty-free diesel oil to all sizes of mechanised fishing vessels without obligations towards export performance. The Government of India provides at present exemption of central exise duty on diesel oil used by fishing vessels of not less than 13.7 m in length fitted with an engine which should not be less than 150-BHP, at the rate of 1.08 kl for every tonne of prawns exported. It has been reported that the Ministry of Finance has subsequently agreed, in principle, to liberalise the scheme of extending incentive support of duty for diesel oil to all mechanised fishing vessels irrespective of size and hp of engine and the type of products of export. This outlook of linking exemption of excise duty with the export performance of even all types of marine products has its limitations in serving as an incentive for extending the fisheries in deeper waters as well as for diversification of fishing effort to other resources, the products of which would be mainly consumed in the country. We, therefore, recommend that the concession on diesel oil duty should be extended to all sizes of mechanised fishing craft because oil costs have reached prohibitive limits. A high level committee to go into the question of diesel oil concessions to fishing industry should be set up as a standing machinery to regulate the retail cost of diesel oil for marine fishing, both inshore and offshore.

Insurance of Mechanised Boats

38.8.22 Mechanised fishing boats are insured with the Life Insurance Corporation of India (LIC). The insurance cover is provided against total loss and/or constructive total loss, and/or salvage charges and/or sue and labour charges only. This cover, if required, can be extended to include Collision Liability (3/4 of the liability of the insured vessel) as per Running Down Clause and/or Full Fire Risks, subject to Fire Average Clause. The LIC considers that a wider cover to include partial loss or damage would entail larger premium rate, which may even be 10 per cent of the sum insured so as to meet the possible frequent claims and cost of surveying the damage. The fishing industry would not be able to afford this rate for obtaining a wider cover.

38.8.23 The LIC has differential rates of insurance premiums for boats operating on the west and east coasts. With a more or less definite period of monsoon on the west coast and specific period of lay-up of mechanised boats, the premium rates have been settled around 2.5 per cent of the sum insured. The rates are higher for the east coast due to greater frequency of cyclones and weather hazards. For the fishing boats operated off Andhra coast the rates indicated are: 4 per cent with monsoon lay-up and 4.5 per cent without monsoon lay-up. The rates have been raised because the cost of claims against the insured value came to 4.3 per cent during 1967-68 when the premium rates varied between 2 and 3.5 per cent indicating the proportionate loss to the LIC. In Tamil Nadu, the total claim cost including salvage charges, survey fees, etc. during 1965-69 was 3.38 per cent on the sum insured, and on this account the premium rate of 3.5 per cent has been indicated.

38.8.24 Of the total number of mechanised boats in the country, 80 per cent are operating off the west coast and only 20 per cent on the east coast. This would indicate the proportionate volume of business and premium income from the two coasts. The small amount of loss incurred by the LIC in some years on only 20 per cent of the total volume of business should not constitute a justification for continuing the differential rates of premiums. The valuation for determining the rates of premiums should be based on the total claims against the premium income for the whole country. We recommend that the LIC should examine the adoption of uniform rates tenable throughout the country with necessary surcharge for boats without monsoon lay-up.

38.8.25 It has been the experience of LIC that in most of the cases, policies are taken only for insurance amounts equivalent to the outstanding loans against the vessels or only the engines, because of compulsion under the loan terms. These amounts are considerably lower than the actual value of the vessels. With this under insurance, the proponents generally expect full salvage charges or collision liabilities to be met. They do not appreciate that claim is settled in the proportion that sum insured under the policy bears to the actual value of the vessel. Under-insurance is, therefore, disadvantageous in each situation. Besides, the need for insurance is not understood by the fishermen. We are of the view that the need for insurance coverage of the entire value of mechanised boats should be fostered by the LIC in coordination with the State fisheries organisations.

9 MARINE FISHERIES POLICY

38.9.1 The Commission feels that large scale development of marine fisheries involving heavy investment and offering vast economic potentialities for the country, but concerned with the exploitation of an international resource, should be guided by a clear and far-sighted policy. As stated elsewhere in this chapter, marine fishing in India has mainly progressed during all these years using indigenous craft for the exploitation of the waters immediately near the coast line. The next step has been the installation of engines in the boats either existing or newly designed, to secure better coverage for fishing operations, and quicker return to the base. By this process fishing has been extended from the immediately inshore areas to something like 20 to 30 kms. Use of mechanical power later extended from propulsion of craft to the handling of gear. The introduction of the medium trawlers of about 15 to 20 m which were able to go out still longer distances and remain on the high seas for a few days, but not exceeding a week, was the next logical step forward. A few efforts at fishing with larger trawlers covering much longer distances with ability to stay away for two weeks or more were tried from the main harbours at Bombay, Cochin, Calcutta and Visakhapatnam, but the number of such trawlers capable of making distant operations for fishing even up to this magnitude has not been many. During the late sixties, however, there was much interest in larger trawlers and the country was getting prepared to embark on a greater expansion in this sphere of marine fishing by making investments on larger vessels.

38.9.2 The concept of a distant water fishing fleet, however, needs an explanation as this has undergone some changes in the last few years, owing to what may be called conflicts of ideas relating to the ownership of fisheries adjoining maritime countries. The extreme instance of distant water fishing is that of the exploitation of the Antarctic whales by countries like Norway and Japan where fleets travel several thousand miles involving absence of several months from the home ports. The more common type of distant water operations is the one in which Japan, Soviet Union, United States, Poland, Norway, Federal Republic of Germany and a few other nations have been traditionally engaged in, but particularly so, the fishing fleets of Japan and Soviet Union in recent times. From their home-based ports, fishing fleets of Japan have traversed almost all the seas the world over and caught fish, a good quantity of them being processed on board; the processed catch and the more expensive types of fish which have a lucrative home market in the frozen state being brought back to the home ports. Japanese fishing fleets are thus known to exploit fisheries in all the world oceans and they have a sizeable activity in the Indian ocean. In recent years the Soviet has made similar heavy investments on their distant water fishing fleet for exploitation of fishing grounds far away from their country, off the coast of Canada, Africa, Australia and South Asia. In view of the considerable wealth in Indian ocean fisheries, the logical step for India would have been to develop a distant water fishing fleet at least capable of operating deep into the Arabian Sea, Bay of Bengal and the northern parts of the Indian ocean regions, which are geographically adjacent to the country and in which India would naturally like to see that she is a major user of its resources as an adjunct to the country becoming a major maritime power in the region.

38.9.3 In the discussion on the productivity of the oceans, it has been mentioned that the best fishing grounds are generally in waters above the continental shelf or in other areas subjected to upwelling. Indian efforts at distant water fishing would, therefore, have meant the operation of larger vessels within the shelfs or upwelling areas over and above the Indian shelf region which will be near southern Arabia, Africa and South Asia. These are precisely the regions which were also considered favourable for exploitation by distant water fishing fleet of other countries like Soviet Union and Japan.

38.9.4 Until recently, fishing in the high seas has been considered as one of the freedoms of the oceans along with the right of navigation and overflight, by which the right to fish in any part of the oceans was inherent to all. Outside the territorial sea of any country, the oceans were the common property of mankind and nationals of any country were free to fish in that area. The fishery jurisdiction of the coastal countries ceased with their own territorial waters; in the case of India upto 19.2 km. The recent series of conferences on Law of the Seas under the United Nations have completely changed this concept, mainly through the pressure of the developing countries of the Africa, Asia and Latin America. The emerging law of the seas has recognised upto 320 km beyond the territorial waters of a country as its exclusive economic zone. Thus, in addition to the complete sovereignty exercised by the coastal country in the territorial sea there will be an added 320 km of the sea the resources within which, both living and non-living, will exclusively belong to the coastal country. India has long been a champion of the need for an exclusive fisheries zone outside the territorial seas and it is in this context that the 1956 Proclamation by the President of India was issued assuming powers to regulate fishing within 160 km of our coast line for the conservation of the fisheries should that be necessary. The addition of a 320 km distance beyond our coast as an arena of marine fishing operations exclusively ear-marked for the country has accrued to the nation, great opportunities and responsibilities. This has minimised the need for heavy investments on distant water fishing fleet in the older sense because it is unlikely that India will be in position to go all out to the very rich fishing areas south of Arabia or East of Africa because many such fishing areas will be exclusive to those countries adjoining them. On the other hand, it becomes highly incumbent on us to concentrate our efforts at fishing in a very intensive manner within India's 320 km economic zone. Fishing effort of the future, therefore, will largely be confined to the superjacent waters of the Indian continental shelf and the waters outside the shelf but within the 320 km limit. The fishing fleet development, which is closely linked to the magnitude of operations, the size of vessels, training of the crew, supporting industries etc. has to recognise the new realities of the situation. The pattern of deep sea fishing will be in favour of middle-distance fishing fleet and medium sized trawlers and other types of vessels rather than large ship operation for long distances.

38.9.5 In Chapter 37 on Inland Fisheries and Aquaculture, we have emphasised the importance of mariculture and the need for large scale cultivation of fish, crustacea, molluscs and sea weeds on our coast which will stem from the increased attention likely to be bestowed on our coastal areas.

38.9.6 Indian marine fisheries developing in this direction would also require some thinking on the extent to which the Central responsibilities have to be exercised with reference to the fishing in the territorial sea and the 320 km economic zone. This zone adjoining the coast will, in future, be the area of intense activity in fishing, mineral exploration, defence and navigational installations, oil drilling and coastal aquaculture. Such intense development can lead to conflicting interests and damage to living resources. We recommend that these activities should be coordinated at the highest level involving the National Environmental Committee, the proposed Ocean Science and Technology Agency and the maritime States.

38.9.7 According to Indian Constitution, fishing outside territorial waters is a Central responsibility; fishing within the territorial waters is usually considered as a State subject. In practice, all deep sea fishing and its expansion has only been handled by the Union Ministry of Agriculture and Irrigation although in recent years some of the State Governments have begun to show increasing interest in deep sea fishing. With the large scale expansion in the exclusive fishing area and the absence of any competition from foreign countries within these waters, we would consider it appropriate that a share in the development of the 320 km. economic zone should also be passed on to the maritime States. Already the rights of fishing of the resources of the continental shelf even outside the old territorial waters (pearls and chank) are exercised by the State Governments where such resources exist (Tamil Nadu and Gujarat). The coastal aquaculture can logically be considered an activity which could likewise be carried out by the State Governments. We would also suggest that mechanised fishing upto a prescribed limit within the 320 km. for exploitation by the smaller size boats could also be made a concurrent State activity because both the public sector and the private sector corporations in the many States would take to fishing in this belt. Fisheries research is a concurrent subject but has in effect become more and more the responsibility of the Centre. As a corollary, it would be natural to suggest that the initiative for legislative measures on marine fisheries would stem from the Centre based on research findings but would be enforced more appropriately through State agencies. Adaptive research in the field of aquaculture and utilisation of coastal resources through the transplantation of new species, introduction of new craft and techniques of capture and culture form a field in which the State Governments should play a more positive role.

38.9.8 International rivalry over exploitation of fish stocks has been a feature of marine fishery development in the principal sea fishing banks of the world. When fishing enterprises of Indian ocean countries develop into full scale operations, particularly in countries adjoining India, the possibility for such rivalry and disagreement cannot be ruled out. Possible areas of disagreement, if one may judge from world fishing experience, would probably concern the demersel stocks at the head of the Bay of Bengal, the Wadge Bank to the South of India, the Rann of Kutch and western continental shelf. Migratory stocks and their protection are involved in the *hilsa* fisheries of the coast and the Ganga estuarine system. Widely distributed stock such as the oil sardine of the Arabian sea and the Indo-Pacific mackerel may require in course of time conservation measures in cooperation with other countries. Most essential consideration here is that accurate scientific information on the fisheries around the country has to be built up. As the largest fishing nation in the Indian ocean area, it devolves on India to keep up good international cooperation in the field of marine fisheries and to undertake cooperative research and investigations with the neighbouring countries in subjects of common concern. We recommend that the ICAR should ensure the fullest development of research facilities, expertise and opportunities for cooperation with the neighbouring countries, enabling India to have the most uptodate information on the fish stocks around the country.

10 SUMMARY OF RECOMMENDATIONS

38.10.1 Amongst the various recommendations given in different sections, only the important ones are given below :

1. Considering the potentials of fisheries resources around India, the production of marine fish should be increased from the present average of 1.0 million tonnes per annum to at least 3.5 million tonnes per annum after 25 years.

(Paragraph 38.3.6)

2. The strategy for utilising the extended resources of pelagic fisheries, recently discovered beyond the traditional zone of exploitation off Kerala and Karnataka, should be soon developed by the Centre and concerned States but without hindrance to the fishery in the traditional zone.

(Paragraph 38.3.17)

3. For increasing production from the Wadge Bank fishery, the State Governments of Kerala and Tamil Nadu should formulate specific schemes, particularly developing fishing effort by mechanised boats.

(Paragraph 38.3.18)

4. The progress in marine fisheries resources survey, carried out in the last 25 years, has been very unsatisfactory. Some of the deeper water resources already surveyed and found productive are not being put to utilisation by the private sector or the State public sector organisations in the industry, indicating a need for a public sector organisation supported by the Centre to give a lead to the industry. The DSFO and IFP, both under the Union Department of Agriculture, should be restructured into a Marine Fisheries Development Organisation or Corporation, giving it a considerable autonomy in operations. Unserviceable vessels should be scrapped without further loss to the public exchequer. The remaining vessels of the DSFO and IFP should be regrouped into two fleets : (a) A research fleet for survey and assessment to be directed by the research agencies of the ICAR and (b) A fishing fleet for experimental and commercial fishing to be handled by the proposed Marine Fisheries Development Organisation.

(Paragraphs 38.3.11, 38.3.12,
38.3.14, 38.3.24,
38.3.28 and 38.3.29).

5. The CMFRI in coordination with NIO, should lay greater emphasis in the future programmes of research on the effects of environmental factors on different types of fisheries, particularly correlation of oceanographic and fishing conditions.

(Paragraph 38.3.22)

6. The resources survey and assessment being a research function, should be the responsibility of ICAR, through the CMFRI, in coordination with CIFT, NIO and other Central, and State fisheries organisations. The combined leadership of the programmes may be vested in a senior scientist to be nominated by the ICAR from any one of these organisations but with unambiguous delegated authority for the framing and execution of survey and assessment programmes. The ICAR should see that the provision for adequate fleet of research vessels and prevailing rules and procedures for their maintenance do not constitute a constraint in the progress of work.

(Paragraphs 38.3.25, 38.3.26,
38.3.27, 38.3.29,
38.3.30 and 38.3.31)

7. The Ministry of Agriculture and Irrigation should set up a working machinery in coordination with the Chief Civil Hydrographic Office, NIO, CMFRI and other concerned research organisations for the preparation of fishery charts.

(Paragraph 38.3.32)

8. In the absence of repeat subsidy to the fishermen for replacements of unserviceable mechanised boats, the State Governments should institute a system of preferential loans for boat and/or engine replacement.

(Paragraph 38.4.9)

9. It should be seen that the withdrawal of subsidies by the State Governments does not constitute a constraint on the progress of mechanisation of fishing boats in those areas still having further scope for expansion of coastal fisheries.

(Paragraph 38.4.10)

10. Construction of larger fishing vessels with steel hulls should be limited to those yards willing to specialise in this work, execute orders in good time and be responsible for a package deal for assembling the complete vessels, their repair and maintenance. Design improvement and operational efficiency should be included in the working system of these yards.

(Paragraph 38.4.16)

11. The need for further import of larger trawlers beyond the numbers which are in the pipeline should be reviewed carefully by the government. But the import of new prototype vessels should be liberally allowed to help the development of indigenous construction of fishing vessels for offshore fisheries. The CIFT should strengthen its craft and gear section with personnel qualified in naval architecture for developing designs to suit Indian conditions.

(Paragraph 38.4.21)

12. To avoid conflicts amongst the operators of non-mechanised craft, mechanised boats and larger fishing vessels, and between the fishermen of adjoining States, the government should undertake necessary measures for delimitation of fishing zones through legislation.

(Paragraph 38.4.22)

13. The practice of discarding the trash fish overboard by the operators of the larger fishing vessels with refrigerated holds or freezing facility on board, should be curbed, and if need be, the possibility of installation of 'pocket' size fishmeal plants on board should be examined. Reporting the catch, in quantity and quality, by all vessels above 25 GRT to CMFRI should be made obligatory.

(Paragraph 38.4.23)

14. The CIFT should actively study the use of Fibre glass Reinforced Plastic for mass assembly of smaller craft in view of the high cost and shortages of timber, particularly for canoes and catamarans. The Institute should evolve a clear categorisation of craft and the material to be used to give the most economic results, short term and long term. Wider trials of ferro concrete craft should also be made.

(Paragraph 38.4.36)

15. It should be seen that marine diesel engines are marketed with ISI certification after working out standard tests jointly by CIFT and ISI, and should have a reasonable period of guarantee. The manufacturers should develop adequate repair facilities at important fishing centres so that the mechanised boat operators do not lose fishing time due to engine breakdowns.

(Paragraph 38.4.40)

16. As the prevailing prices of marine diesel engines are prohibitively high, the government should examine the possibility of scaling down the cost through : (a) examination of the price structure to regulate profitability; (b) limiting manufacture to a reduced number of industrial units; and (c) giving relief in the sales tax and the excise duty.

(Paragraph 38.4.41)

17. The CIFT and the Fisheries research organisations in the maritime States should intensify research in coordination on the traditional gear systems with a view to bringing about improvements in per capita productivity and economic returns to the marine fishermen. Investigations on gear technology of midwater trawling, semi-pelagic trawling and purse-seining should also be intensified, seeking foreign expertise wherever necessary.

(Paragraphs 38.4.47 and 38.4.51)

18. The CIFT alongwith fisheries departments of maritime States should strengthen their extension services and demonstrate the economic advantages of various types of modern fishing devices particularly fish finders/echo sounders and deck equipment for the operation of different types of gear. The CIFT should liaise with the electronic industry to develop and market in the country a robust and versatile echo sounder for the smaller mechanised craft and trawlers. The instruments and deck machinery required and now manufactured in India should be standardised through the cooperation of the CIFT and ISI, keeping in view the need for reducing the number of items and their specifications, and the need for interchangeability of equipment.

(Paragraphs 38.4.57 and 38.4.58)

19. With considerable prospects of increasing export earnings from the products of oceanic tuna, India should make an early entry into commercial fishing for high seas tuna in the Indian ocean. This would also enable India to have more effective participation in the international management of the tuna resources in the Indian ocean. Expert foreign assistance may be sought to accelerate the process of developing tuna fishing by Indian private industry and the proposed Marine Fisheries Development Organisation.

(Paragraphs 38.5.7 and 38.5.9)

20. The exploitation of skipjack fishery resources in the Indian ocean by purse seining, particularly around the Indian Islands should be given special attention in the development of high seas fishing for tuna.

(Paragraph 38.5.8)

21. Despite the importance of fishery harbour facilities in the development of marine fisheries, the progress in this work has been very slow. For provision of basic facilities at suitable fishing centres in each maritime State, a comprehensive report on planning of minor harbour works should be prepared as expeditiously as possible for immediate action. Priority consideration should then be given to

the construction of these smaller works for giving an early relief to the fishing industry.

(Paragraphs 38.6.5 and 38.6.6)

22. The Ministry of Agriculture and Irrigation, in consultation with the Governments of the maritime States, may work out a scheme for the re-organisation of the Pre-Investment Survey of Fisheries Harbours Project so as to make it responsible not only for the formulation of the projects of the fishery harbours outside the jurisdiction of the Port Trust Authorities, but also for the execution of the harbour works. The same organisation should estimate the requirement of the dredging work and procure necessary dredgers as a central pool for the construction of fishery harbours.

(Paragraphs 38.6.10 and 38.6.11)

23. The procedures for sanctioning fishery harbour projects by the Government of India should be streamlined to avoid undue delays which have occurred in the past resulting in several cases in the revision of estimates and need for fresh sanctions.

(Paragraphs 38.6.12 and 38.6.13)

24. On commissioning the fishery harbours, the State Governments should devise a suitable machinery for management and proper maintenance of fishery harbours as well as for levy and collection of port dues and other charges.

(Paragraph 38.6.14)

25. To expedite the construction of major fishery harbours by the port trust authorities, the government may accept the procedures suggested.

(Paragraph 38.6.17)

26. To make fisheries harbours fully functional at the time of their commissioning, planning for provision of facilities such as roads, processing plants, water supply, electricity etc. by the State Governments should be synchronised with the construction of fishery harbours by the Central Government. The Centre and the State Governments should formulate specific schemes for expansion of fishing effort involving operations of fishing vessels based from harbours as and when they are commissioned.

(Paragraph 38.6.18)

27. In the absence of specific rules and regulations, under the Indian Merchant Shipping Act (1958) for the navigation, registration and manning of mechanised fishing boats below 25 Gross Registered Tonnage, difficulties are being experienced by the fishing industry. The Ministry of Agriculture and Irrigation should arrange to get the necessary rules framed, as expeditiously as possible, by the Director

General of Shipping, giving due consideration to the specific conditions of the industry and recognition of the certificates awarded by the States Directorates of Fisheries and the Central Institute of Fisheries operatives as the necessary Competency Certificate for operating the boats outside the harbour limits.

(Paragraphs 38.7.3 and 38.7.4)

28. There should be a uniform pattern of training at all the fishermen training centres in the States, and rules for proficiency test, syllabus etc. should be framed jointly by the fisheries organisations in the maritime States and the Centre in consultation with the Director General of Shipping.

(Paragraph 38.7.4)

29. The fisheries organisations in the States should take necessary steps to enable the fishermen training centres to assume additional function of developing necessary liaison and building up extension service among the working fishermen in the coastal region with a view to improving their working system.

(Paragraph 38.7.5)

30. The grant of remissions in the sea-time/workshop time, being given as a matter of discretion by the Mercantile Marine Department to the institutional trainees, should be a general rule applicable to all candidates sponsored for examination by approved institutions.

(Paragraph 38.7.9)

31. All the rules and regulations pertaining to navigation, registration, manning and examination should constitute a separate Chapter in the provisions of the Indian Merchant Shipping Act (1958) and a separate booklet containing this chapter alone should be brought out for the use and guidance of the fishing industry.

(Paragraph 38.7.10)

32. The candidates appearing for the Competency Certificate examinations of fishing secondhand and skipper, held by the Mercantile Marine Department only in the disciplines of navigation and seamanship, should first qualify for the proficiency Certificate in fishing to be awarded under the authority of the Ministry of Agriculture and Irrigation.

(Paragraph 38.7.11)

33. The present system of institutional training should be modified in such way that the institutional candidates, appearing for Competency Certificate examination of fishing secondhand and engine driver, should gain necessary qualifying sea-time/workshop time in between the institutional training.

(Paragraph 38.7.12)

34. The key post in manning fishing vessels larger than 25 GRT being that of a skipper requiring 60 months of sea-time to qualify as a candidate for the Competency Certificate, it should be seen that in planning for the development of offshore fisheries the availability of skippers should not constitute a constraint.

(Paragraph 38.7.13)

35. Economic studies on the cost and return functions in different fishing methods and on the status of the fishermen in different maritime States should be jointly undertaken by the State fisheries organisations and bureaus of economics and statistics for subsequent review at the Centre for planning developmental programmes and determining their economic impact.

(Paragraph 38.8.3)

36. To involve the small and marginal section of the marine fishermen community in the production process, the feasibility of organising cooperatives of the type of Farmers' Service Societies on a pilot basis may be examined by the maritime States.

(Paragraph 38.8.7)

37. A comprehensive review of the existing marine fisheries co-operatives may be undertaken with a view to assessing the type of assistance needed, both managerial and financial, to make the uneconomic cooperatives viable. The feasibility of reorganising some of the non-viable units on the lines of the Farmers Service Societies should also be examined.

(Paragraph 38.8.8)

38. The cooperative societies should perform the additional functions of mobilising savings considered necessary for consumption by fishermen during the cessation period of fishing in monsoon, so as to save them from the exploitation by the middlemen.

(Paragraph 38.8.9)

39. With a view to expanding fishing effort in the exploitation of offshore fisheries, the Government of India should suitably modify the grant of subsidy scheme so as to cover fishing vessels of all types of hull materials and of adequate sizes as to have the minimum endurance capacity of remaining at sea for more than 72 hours.

(Paragraph 38.8.14)

40. There being a need for giving incentive support of the industry in developing offshore fisheries the grant of preferential loans with grace periods of low interest to be routed through the public sector fisheries corporations in the States in case of fishing vessels upto 25 GRT and through Marine Products Export Development Authority in case of vessels above 25 GRT may be examined.

(Paragraphs 38.8.18 and 38.8.20)

41. Concession on diesel oil duty should be extended to all sizes of mechanised fishing craft. A high level committee should be set up to periodically review the question of diesel oil concessions to the fishing industry as a standing machinery to regulate the retail price of diesel oil for marine fishing both inshore and offshore.

(Paragraph 38.8.21)

42. Instead of charging variable rates of insurance premiums as at present for mechanised boats operating in different States, the LIC should examine the adoption of uniform rates tenable throughout the country, with necessary surcharge for boats without monsoon lay-up. The need for insurance coverage of the entire value of mechanised boats should be fostered by the LIC in coordination with the State fishing organisations.

(Paragraphs 38.8.24 and 38.8.25)

43. Marine fishery policy for India should be recast in the light of an exclusive fishery zone adjoining to coast. The accent on distant water fishing fleet should be replaced in favour of more concentrated effort for the exploitation of the seas within 320 km of the Indian coast. The requirement of vessels in future should be more for medium-sized vessels rather than large vessels capable of long absence from the base.

(Paragraph 38.9.4)

44. The economic zone adjoining the coast will, in future, be the area of intense activity in fishing, mineral exploration, defence and navigational installations, oil drilling and coastal aquaculture. Such intense development can lead to conflicting interests and damage to living resources. These activities should be coordinated at the highest level involving the National Environmental Committee and the proposed Ocean, Science and Technology Agency and the maritime States.

(Paragraph 38.9.6)

45. In the development and utilisation of the exclusive fishery zone adjoining the coast, the concerned States should have a responsible share.

(Paragraph 38.9.7)

46. On the question of scientific research on fish stocks and related problems, the ICAR should ensure the fullest development of research facilities, expertise and opportunities for cooperation with the neighbouring countries, enabling India to have the most uptodate information on the fish stocks around the country.

(Paragraph 38.9.8)

APPENDIX 38.1

Production Features of Constituent Fisheries

(Paragraph 38.2.8)

Constituent fishery*	Range of fluctuations in annual fish landings during 1963-72 (thousand tonnes)		Average annual fish landings during 1963-72 (thousand tonnes)	Percentage contribution
	Lowest	Highest		
1	2	3	4	5
oil sardine	63·6(1963)**	301·4(1968)	215·1	23·7
Harpodon nehereus	51·5(1972)	91·9(1963)	75·9	8·3
Mackerel	20·8(1968)	184·8(1971)	75·1	8·2
Penaeid Prawns	35·8(1965)	90·0(1970)	63·6	7·0
other sardines	27·2(1963)	63·8(1971)	45·9	5·0
non-penaeid prawns	29·4(1967)	85·5(1972)	43·8	4·8
Elasmobranchs	29·6(1967)	45·3(1972)	37·4	4·1
Leiognathus	17·7(1963)	49·3(1970)	35·0	3·8
Ribbon fishes	16·5(1963)	45·3(1971)	32·5	3·6
Sciaenids	22·6(1963)	41·9(1970)	30·1	3·3
Catfishes	17·6(1963)	50·6(1970)	29·8	3·3
Anchoviella	18·4(1968)	31·4(1969)	24·6	2·7
other clupeids	14·5(1963)	29·5(1971)	23·1	2·5
Caranx	17·5(1963)	26·9(1964)	21·0	2·3
Pomfrets	17·3(1963)	27·8(1968)	21·0	2·3
Seer fish	9·1(1963)	21·2(1972)	12·7	1·4
Perches	8·1(1965)	14·5(1972)	11·3	1·1
Soles	6·1(1967)	13·4(1970)	9·5	1·0
Chirocentrus	7·3(1965)	10·6(1968)	8·8	1·0
Thrissocles	4·8(1965)	14·1(1970)	8·8	1·0
other Hilsa	5·3(1963)	12·3(1972)	8·2	0·9
Lactarius	4·5(1969)	8·7(1967)	6·2	0·7
other crutaceans	2·1(1963)	11·5(1972)	6·0	0·7
Polynemids	1·7(1965)	7·5(1971)	4·3	0·5
Tunnis	3·0(1970)	5·9(1972)	4·1	0·4
Eels	2·3(1964)	8·7(1963)	4·0	0·4
Bregmaceros	1·7(1969)	5·5(1965)	3·5	0·4
Red mullets	1·4(1967)	5·9(1972)	3·3	0·4
Flying fish	0·4(1965)	9·2(1971)	3·0	0·3
Chorinemus	2·1(1970)	3·5(1966)	2·8	0·3
Mugil.	1·4(1965)	3·7(1971)	2·4	0·3
Saurida and *Saurus*	0·5(1965)	4·5(1972)	2·3	0·3
Sphyraena	1·1(1966)	4·4(1967)	1·9	0·2
Hilsa ilisha	0·7(1969)	3·4(1964)	1·6	0·2
Hemirhamphus and *Bolone*	0·7(1972)	3·4(1963)	1·5	0·2
Cephalopds, Coryphena Elacate, other Carangids, *Gazza*	3·3(1964)	5·2(1970)	1·6	0·1
miscellaneous	21·8(1965)	42·4(1972)	29·3	3·2
total	655·5(1963)	1155·8(1971)	911·0	100·0

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* The names of the fisheries are according to the proforma adopted by CMFRI.

** The figures in brackets indicate the years when lowest/highest fish landings were recorded.

APPENDIX 38.2

(Paragraphs 38.3.4 and 38.3.14)

State-wise Information on Continental Shelf, per annum Production and Potentia.

State/Union Territory	Gujarat	Maharashtra	Goa	Karnataka	Kerala	Lakshadweep	Tamil Nadu	Pondicherry	Andhra Pradesh	West Bengal & Orissa	Andaman Nicobar	Total
(A) continental shelf area (sq. km.) .												
(i) up to 50 m depth . .	64,810	25,512	2,849	7,936	12,569	..	23,255	..	16,607	27,001	..	180,539
(ii) up to 200 m depth . .	99,373	104,758	9,984	25,473	35,941	4,336	41,412	..	31,044	46,491	16,056	414,868
(B) (i) length of the coast-line (km) .	1,500	600	110	270	560	..	960	..	970	680	..	5,650
(ii) average distance up to continental shelf km	66.2	174.6	90.8	94.3	64.2	..	43.1	..	32.0	68.4	..	..
(C) average annual catch (thousand tonnes)												
(i) demersal	20	100	6	7	65	0.2	44	5	21	4	0.1	272.3
(ii) Pelagic	60	80	20	60	290	0.4	91	8	59	7	0.2	675.6
(iii) total	80	180	26	67	355	0.6	135	13	80	11	0.3	947.9
(D) potential yield (thousand tonnes)												
(i) demersale												
(a) up to 50 m	97	160	10	25	70	..	60	*	30	27	..	479
(b) 50—200m	52	100	5	13	20	..	13	*	17	19	..	239
(c) total	149	260	15	38	90	4	73	*	47	46	16	738
(ii) Pelagic			1020						670			1690 2,428

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*Included under Tamil Nadu.

APPENDIX 38.3

(Paragraph 38.4·4)

Statewise Distribution of Non-mechanised Fishing Craft*

(numbers)

State	Catamarans	Dogout canoes	Plank-built		Total
			9·75 m or above in length	Less than 9·75 m in length	
West Coast					
Kerala . . .	6,056	8,964	4,846	7,630	27,496
Maharashtra . .	198	6,303	812	2,951	10,264
Gujarat . . .	127	1,897	846	1,078	3,948
Karnataka . . .	1,342	3,330	1,248	3,522	9,442
Goa	N.A.	N.A.	N.A.	N.A.	N.A.
Lakshadweep . .	13	1	80	917	1,011
East Coast					
Andhra Pradesh . .	16,327	752	2,259	3,797	23,135
Orissa . . .	4,401	4,044	4,259	5,082	17,796
West Bengal . .	592	17	707	217	1,533
Tamil Nadu . .	13,504	2,139	1,816	2,567	20,026
Pondicherry . . .	1,326	1	150	311	1,788
Andaman & Nicobar Islands. .	23	858	26	229	1,136
total . .	43,909	28,306	17,059	28,301	117,575
percentage of total non-mechanised craft.	37·3	24·1	14·5	24·1	100

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* Data from Livestock Census, 1966.

APPENDIX 38.4

(Paragraph 38.4.25)

Statewise Distribution of Wooden Boat-building Yards

(numbers)

State/Union Territory	Government	Corporations	Cooperatives	Private	Total
Gujarat . . .	..	..	5	4	9
Maharashtra . .	..	..	2	5	7
Goa	..	..	..	..	..
Karnataka . . .	2	..	3	4	9
Kerala . . .	1	4	1	20	26
Lakshadweep . .	1	..	..	..	1
Andhra Pradesh . .	1	..	..	..	1
Tamil Nadu . .	4	..	1	2	7
Orissa . . .	..	1	1	2	4
Punjab . . .	..	..	1	2	3
West Bengal . .	1	..	..	1	2
total . . .	10	5	14	40	69

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APPENDIX 38.5

(Paragraph 38.6.2 and 38.6.7)

Sites where Fishery Horbour Facilities (Other than Major Harbours) have been Provided or under Construction and Those for Which Project have been prepared by PISFHP

State/Union territory	Fishery harbours where facilities are available or under construction	Pre-Investment Survey of Fishery Harbours Project				Present position
		Site	Year	Capacity for different sizes		
				Size of vessels	No. of vessels	
Gujarat	Porbander, Mangrol, Veraval, Navabunder, Jaffarabad.	(i) Veraval	1974	11·6 14·6 16·0 25·0	380 40 30 15	under consideration
		(ii) Mangrol	1974	11·6 14·6 9·2	120 20 23	under consideration
Maharashtra	..	(iii) Dahanu	1971	10·0 14·0	10 45	under consideration
		(iv) Dighi	1971	10·0 16·0	40 15	replaced by Agardanda being surveyed.
		(v) Ratnagiri	1970	12·0 15·0	155 30	do.
Goa	..	..	..	..	..	..

Karnataka	Karwar	(vi) Honavar	1970	10·0 14·0	80 40	sanctioned in 1973
		(vii) Malpe		10·0 14·0 18·0 23·0 28·0	210 40 16 11 3	sanctioned in 1975
Kerala	Ponnani, Baliapatnam, Mopla-bay, Beypore, Azhicode Vizhinjam	(viii) Neendakara	1972	12·0 15·0	150 40	under consideration
Tamil Nadu	Rameswaram, Nagapatnam, Cuddalore, Tuticorin.	(ix) Chinamuttam	1972	10·0 16·0 28·0	25 30 5	do. —
		(x) Mallipatnam	1972	10·0	54	sanctioned in 1975
		(xi) Kodiyakkarai	1972	10·0	29	do.
Andhra Pradesh . . .	Kakinada	(xii) Ramayapatnam	1974	..		not recommended
		(xiii) Nizampatam	1971	10·0	60	some additional studies being undertaken.
		(xiv) Narasapur	1971	10·0	100	undr consideration.
		(xv) Kakinada	1971	10·0 12·0 16·0	90 45 15	do.
Orissa	Chandipur	(xvi) Dhamra	1971	10·0 16·0	35 15	sanctioned in 1975.
West Bengal	..	..	..	..	..	
Andaman & Nicobar Islands.	Port Blair					

APPENDIX 38.6

(Paragraph 38.7.6)

Percentage Utilisation of different training courses at Central Institute of Fisheries Operatives, Cochin and its Unit at Madras

Name of the training course	Intake capacity per batch (number)		Percentage utilisation		Duration of the course
	Cochin	Madras	Cochin (1963-74)	Madras (1969-74)	(Months)
(A) for manning larger vessels					
(i) fishing second hands	40	40	84·2	85·2	15
(ii) engine drivers	40	40	74·2	77·5	15
(iii) radio telephone operators.	10	10	70·0	98·0	9
(B) shore technicians					
(i) gear technicians .	20	10	49·4	22·0	9
(ii) boat building foremen.	20	10	38·3	..	15
(iii) shore mechanics.	20	..	38·9	..	12
(C) teachers training	10	..	23·3	..	6

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APPENDIX 38.7

(Paragraph 38.8.11)

Liability in terms of total catch per annum for different sizes of fishing vessels to offset the cost functions

	Wooden				FRP	Steel	Remarks
(A) sizes of fishing vessels (m)	9·7	11·0	13·1	14·9	9·9	17·4	
(B) capital cost on fishing vessel and gear (Rs. in lakhs) .	1·07	1·54	3·00	4·00	1·37	10·00	
(C) cost functions in annual expenditure on cost of capital and operational cost (Rs. in lakhs).	0·75	1·10	2·36	2·96	0·71	4·35	
(D) return function in terms of annual catch							
(i) prices—items (in tonnes) to offset cost functions :							
(a) high unit (c_1) =Rs. 10,000 per tonne.							
(b) medium unit (c_3) =Rs. 2,500 ,, ,,							
(c) low unit items (c_3)=Rs. 500 ,, ,,							
or							
for reduction into fish meal =Rs. 250 ,, ,,							
(ii) examples taking different proportions of p, q and r*							
(a) $p=0\cdot0$ $q=0\cdot0$ $r=1\cdot0$ when c_3 = Rs. 500/-	150	220	472	592	142	870	Boat-seining, shore seining, purse seining, semi-pelagic trawling.

APPENDIX 38.7 (Contd.)

	Wooden				FRP	Steel	
when c_3 = Rs.- 250/	300	440	944	1,184	284	1,740	Boat-seining, shore seining purse seining, semi-pelagic trawling.
(b) p=0·1 q=0·1 r=0·8	45	67	143	179	43	264	Bottom trawling with Prawns as 10 per cent, 10% prime fish and 80% lesser types of fish.
(c) p=0·2 q=0·1 r=0·7	29	42	91	114	27	167	Bottom trawling with prawns as 20%, prime fish 10%, lesser varieties 70%.
(d) p=0·0 q=0·2 r=0·8	83	122	262	329	79	483	Bottom trawling with prawns nil, prime fish 20% lesser varieties 80%.
(e) p=0·0 q=1·0 r=0·0	30	44	94	118	28	174	Gill netting and long lining all prime fish.

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* p, q and r are respective proportions of the three types of items in the total quantity of catch, as explained in Remarks column against each example.

39

CRUSTACEAN FISHERIES AND THEIR UTILISATION

1 INTRODUCTION

39.1.1 Among the marine fisheries of the country the crustaceans comprising prawns, lobsters and crabs are by far the most important in terms of value of the catches. Although they form about 15 per cent of the landed wet weight of the marine catch their value exceeds 60 per cent of the total. India's present position as the second among the prawn fishing nations of the world (Appendix 39.1) is undoubtedly the result of progressive developments that have been initiated during the five year plans. The prawn and lobster fisheries of the world were of secondary importance till the second world war but the post-war developments have brought the entire crustacean fisheries into the forefront in different parts of the world. In many places they have replaced traditional fisheries for other species or have relegated them into positions of secondary importance.

39.1.2 In India, the prawn and lobster fisheries have traditionally been exploited by the coastal fishermen using primitive craft and gear. The gradual introduction of modern technology of fishing and fish processing, however, has developed them into a systematic industry in recent years. The insatiable demand for prawns and lobsters in the affluent countries has also provided a fillip to the development of the necessary infrastructure at different centres to manage and maintain this large and expanding export trade and the ancillary industries. With the commencement of the export trade of frozen prawns to the USA in 1953 rapid transformation took place and within a very short time all our established fisheries such as sardines and mackerel have been relegated into positions of less importance. At present India exports about 40,000 tonnes of finished crustacean products valued at over Rs. 70 crores per year to practically all the developed countries of the world. The current anticipated export is of the order of Rs. 100 crores. This phenomenal development of trade has happened within a very short period of two decades. This was possible chiefly due to introduction of mechanisation into the capture fishery. The progress in this direction has been reviewed by Panikkar[1]. The catch of crustaceans and their export have increasing year by year the latter establishing new records of foreign exchange earnings every year. The scope of this trade which is totally dependent on the judicious exploitation of the natural resources of the country is very vast and it holds out prospects of multifarious development in the coming years. The developments have been so rapid that problems concerning conservation and management of the national resources have not been fully taken into consideration during the process. It is, therefore, necessary to make a special assessment of this resource in the light of future developments.

2 PRAWN FISHERIES

Area of Operation

39.2.1 The prawn fishery of the country is mainly supported by littoral forms and they are distributed all along the 5,600 km coastline. Of the estimated 415,000 sq km area of the continental shelf only about 1,12,000 sq km are exploited at present. The existing prawn fishery is restricted to the shoreward side of the continental shelf and the topographical diversity of the coastline probably gives rise to the existing pattern of distribution of prawn fishery in general and to the various species in particular. The traditional craft operating from 1,800 fishing villages along the coastline of India have an operational range of 8 km from the shore and the mechanised fishing vessels concentrated around fishing harbours, river mouths and creeks operate up to 20 km from the shore where the depth is approximately 50 m. From 1967 onwards deep water ground, between 150 and 400 m, particularly those lying on the continental slope off the southwest coast of India, were also fished for deep water prawns. The production of deep water prawns by the 4 or 5 modern exploratory trawlers owned by the Government agencies does not exceed 100 tonnes annually and the species concerned are totally different from the littoral forms.

Species Exploited

39.2.2 A list of species exploited is given in Appendix 39.2. Some of the species indicated in the Appendix are of minor commercial value. The majority of them are marine, most of them with an estuarine phase while a small number is estuarine and fresh water. A description[2] of each major species is given below :

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[1] 6 Paanikar, N. K. & N. K. Menon, 1956 Prawn Fisheries of India, Proc. Indo—Pac. Fish. Counc. (3) : 328—344.

2. 1969. Prawn Fisheries of India : 1—303. Bull No. CMFRI, Cochin.

(i) Penaeus indicus (Milne Edw): Commonly known as Indian prawn, this species is the mainstay of the frozen prawn industry. Among the landed wet weight of prawns the species accounts for about 10 per cent. The species grows to about 200 mm in size although the average modal size of the species in the commercial fishery is 175 mm. This is an ideal species for export and is often obtained in 15—20 counts per kg. The species is also exploited in large quantities from the estuarine regions of the coastal beach water areas where they attain a maximum size of 140 mm (30 to 40 per kg). The species is considered to be the most suitable prawn for culture in Indian waters. Exploited prawns are in 0 and 1 year class from the seas and 0 year class of less than 10 months old from the estuaries.

(ii) Penaeus monodon (Fabr.) : Popularly known as Jumbo tiger prawn, this species is the largest growing of the penaeid prawns known. It attains over 300 mm in size. Its contribution in the commercial fishery is only less than 3 per cent. Nevertheless it is the most valuable of the prawns as they are caught in larger sizes. Processed prawns are often found in U-10 grades (under 10 per kg). From the seas they are caught in small quantities only. But they are caught in larger quantities from the estuaries. These are also an ideal species for culture in the coastal brackish water areas. They grow fast in the estuaries and are known to attain about 230 mm in one year. Availability of their juveniles in the brackishwater regions is relatively poor. But due to their high value in the commercial market it is necessary to find out sources of post-larvae and juveniles of the species and to develop culture fishery of the species. The scarcity and irregular occurrence of the prawn in the commercial catches are perhaps the reasons why it has not been made to spawn under laboratory conditions in India. For the development of the culture fishery for the species it is essential that the spawners of the species are obtained and seed prawns are produced. In view of this it is recommended that research work on the culture of this species be intensified.

(iii) Penaeus semisulcatus (de Haan) : Popularly known as white tiger, the species is also an important prawn for freezing and export. It grows to about 220 mm (10 headless prawns per kg). In the commercial fishery this species also forms less than 3 per cent, but it is a prawn with great demand. This species has relatively deep water distribution in the littoral zone and they are mostly obtained from the east coast centres. In the estuarine catches they are scarce. Prospects of better catches of this species is evident from the east coast centres with the expansion of capture fishery in the east coast. The species is likely to become a very important component of the exported prawns from the country. Work on the biology of this species requires intensification.

(iv) Metapenaeus dobsoni (Miers) : Popularly known as flower tail prawn, this species is the mainstay of the prawn catches of the country and it forms over 30 per cent of the penaeid prawns. The species is relatively smaller and its maximum size is recorded as 130 mm. In the fishery from the seas its modal size is 100-105 mm. They are very common in the estuarine environments where they grow to the size of 90 mm. The juvenile prawn fishery of the estuaries of Kerala is mainly supported by 40-60 mm size of the species. The sea fishery for the species is formed of 0 and 1 year class less than 6 months old. In the processing industry this prawn provides raw material of cooked and frozen prawn meat and also for canning. The prawn is widely distributed in both the coasts of India. But the bulk of the catches comes from Kerala and Karnataka coast. In the mud bank prawn fishery of Kerala during the monsoons *M. dobsoni* is the predominant species. The species is ideally suited for culture in brackish water areas as it thrives very well in that environment. But the relatively smaller size attained by the species relegates it to a position of secondary importance when compared with larger growing culturable species.

(v) Metapenaeus monoceros (Fabr.) : Popularly known as Indian pink prawn, this species is distributed in the seasoned estuaries on both the coasts of India. It is relatively large sized species attaining maximum length 180 mm. Its average size in the sea fishery is 150 mm. It is extremely seasonal fishery in the west coast of India where it occurs for a short period in October-November. In the total production it forms about 50 per cent of the penaeid prawns landed. Being relatively deep water form in the adult stages they are obtained in the trawl nets. In the exploited fishery from the seas the species falls in 0 and 1 year class. In the estuaries they form sizeable portion of the catches and among the other penaeid prawns this species is adaptable to very low salinity conditions. *M. monoceros* is processed as frozen prawn, peeled and deveined, prawn meat and canned prawn. This is also a suitable species for culture operations. It is particularly suitable to such areas where the variations of salinity are high.

(vi) Metapenaeus affinis (Milne Edw.): Popularly known as grey prawn, this species is very similar to *M. monoceros* in its distribution and general biology. It is distributed in both the coasts of India and it forms considerable portion of the trawl catches in October-November period. Maximum size of the species is reported to be 170 mm and the modal size as 140-145 mm. It forms about 4 per cent of the total catches. The species is predominantly occurring off the Karnataka and Maharashtra Coasts. In the estuarine fisheries it is obtained in relatively small quantities. The sea fishery for the species is generally in 1 year class.

(vii) Metapenaeus brevicornis (Milne Edw.) : Popularly knows as yellow prawn this species is very common among the prawn catches along the north east and north west coast of India. The species attains a maximum size of 127 mm with modal size between 105-110 mm. It forms only about 3 per cent of the penaeid prawns landed. Predominant catches of the species are obtained from the Andhra Pradesh, West Bengal coast and from Maharashtra coast where they are common in the shallow inshore waters. *M. brevicornis* inhabit the estuarine waters and they are fished in substantial quantities from the areas associated with the river mouths of the Krishna, Godavari and Mahanadi. It is suitable for processing as cooked and frozen prawn meat and canned prawn. It is suitable for culture in the estuarine regions. But its relatively small size gives it lesser commercial value.

(viii) Parapenaepsis stylifera (Milne Edw.) : Popularly known as Indian brickred prawn, this species is endemic in the inshore regions of both west and east coasts. It forms nearly 30 per cent of the penaeid prawns landed in the country and it supports bulk of the raw material for preparing prawn meat for freezing and canning. Maximum size of the species is recorded as 145 mm although modal size in the catches in 110-115 mm. It is generally in 0 and 1 year class. Among the exploited species of the penaeid prawns of India this is perhaps the only one known to spend the entire life history in the seas. It is rare in the low saline areas and is never caught in large numbers from the estuarine areas.

(ix) Solenocera indica (Natraj): This is another penaeid prawn which is found commonly occurring among the prawn catches landed in the Maharashtra region on the west coast and in lesser quantities in coastal Andhra Pradesh on the east coast. This species grows to a size of 114 mm but the modal size in the fishery is recorded as 71-75 mm. Its occurrence is highly seasonal in Bombay where it is caught in October-November in commercial quantities. The life span of the species is estimated to be about 14 to 15 months. *S. indica* is suitable for freezing and canning.

(x) Non-penaeid prawns : The non-penaeid prawns account for more than 60 per cent of the total crustacean landings. The catch of this category, however, has declined considerably in recent years and this is no doubt the result of the excessive importance given to the capture of export variety of penaeid prawns. Unless suitable use of these small prawns is found out this trend is bound to continue. This category of prawns is formed of smaller sized (Prawns) types and the important species among them are *Palaemon tenuipes* (*Henderson*), *P. styliferus* (Milne Edw.), *Hippolysmata ensirostris* (Kemp) and *Acetes indicus* (Milne Edw.). Among this group special mention may be made of the species *Acetes indicus* which is a swarming prawn growing to a maximum size of 35 mm. This species appears in very large quantities throughout the Maharashtra coast in the inshore stake net catches during the months of December to February. At present bulk quantities of this species amounting to several thousands of tonnes are utilised for making dried prawn in very crude pattern and they are being used by the very poor section of the population. There is vast scope for developing shrimp powder industry by using this as a raw material. Perhaps other methods of sophisticated use of this prawn can also be found out through directed research.

(xi) Macrobrachium resenbergii (de Man) : Popularly known as 'Giant fresh water prawn', this species is endemic in the rivers of both east and west coasts of India. It is the largest growing prawn and is fished from the natural habitat in certain areas of West Bengal, Andhra Pradesh, Kerala, Maharashtra and Gujarat in relatively small quantities. In the 1960s an average quantity of 400 tonnes of this species was exported from the country but the capture of fishery for the species has declined and there is hardly any export of this species at present from India. The species is cultivated in fresh water impoundments in many parts of the world, to satisfy the demands from the gourmets. The cannibalistic tendencies inherent in the species, however, act as limiting factor in the wider application of its culture. An allied species *M. malcolmsonii* (Milne Edw.) also holds out similar prospects for development of culture fishery. Systematic culture of these species in the Indian waters may be developed.

Craft and Gear

39.2.3 According to the latest estimates, there are about 117,000 traditional indigenously manufactured fishing craft along both the coasts of India. These craft can be basically classified as follows :—

(i) catamarans, 6m×0.7m to 7.6m×1.4m, used in southwest coast and southeast coast.
(ii) dug-outs, 4. 0m×0.6m to 8.0m×1.4m, used in southwest coast of India.
(iii) plank built boats, 6.6m × 0.9m to 14.0m × 3.1m, used in northwest coast, northeast coast and in some southern regions.

Details of these craft are discussed in the Chapter 38 on Marine Fisheries. The gears used by the catamarans are small boat seines and gill nets. The canoes also use boat seines and gill nets and plank built boats use large stake nets and boat seines. Some of these crafts are also used in the operation of shore seines and cost nets for prawns. Most of the prawns come in general fishing operations in the sea.

39.2.4 The mechanised fishing boats entered the capture fishery for prawns in the early 1950s. There exists considerable diversity in the matter of size and the power of the engines used by the mechanised fishing boats. They are indigeneously built wooden boats and the majority of them are provided with decks. Their sizes vary from 6.6 to 12.5m in length and they use 10 to 60 BHP inboard engines. There are probably over 10,000 of these boats along the coasts of India. In addition to these there are about 100 larger trawlers between 17 and 33 m in overall length, fishing from different ports. They are mostly steel built vessels and are equipped with refrigerated fish holds. The operation of most of these trawlers is only for exploratory work and they are owned by Government agencies. Some of these vessels are owned by fishing companies controlled by larger business houses of India. All these boats operate shrimp trawls with 15 to 52 m head rope having 22 to 32 mm mesh size at the cod end. A few of them are double rigged trawlers.

39.2.5 The mechanisation of the craft used in the capture fishery is an accepted necessity and these craft are eventually to replace the less efficient indigenous craft. To meet the requirements of fishing in creeks and shore waters, smaller craft (5 to 6 m) with out-board engines will be suitable. Production of out-board engines suitable for this may be taken up within the country. The 9.6 m mechanised vessel with 40 BHP engine is considered suitable for replacing the presently used indigenous craft and as such their increased production within the country should be encouraged.

39.2.6 One of the essential needs of the prawn fishing industry is the acquisition of necessary facility to fish in deeper regions of sea without having need to come to the shore every day. This can be done only by craft, steel built or otherwise of more than 17 m in length with necessary facilities. While construction of such boats in the country is to be encouraged import of some prototypes should also be allowed so that the quality of the indigenously manufactured vessels can be maintained. As the production of large sized prawns from the deeper waters is imperative in the present context, the main thrust is to be on the provision of the medium sized trawlers, particularly of the imported designs for the time being.

Exploitation

39.2.7 The statistics of catch of crustaceans in the country are computed under three broad categories namely (a) penaeid prawns, (b) non-penaeid prawns and (c) other crustaceans. The penaeid prawns include large sized prawns belonging to the genera *Penaeus, Metapenaeus and Parapenaeopsis,* which are generally exported while the non-penaeid prawns are smaller mixed ones chiefly belonging to the families Palaemonidae and Hippolytidae. The other crustaceans comprise lobsters and crabs.

39.2.8 Systematic data on the crustacean landings are available from 1950 onwards. Subject to normal fluctuations associated with the exploitation of a natural self generating resource, the crustacean catches of the country increased from 71,000 tonnes in 1960 to 183,000 tonnes in 1974 (Appendix 39.3). Thus there has been an increase of over 158 per cent within the last 15 years. This trend of increase is generally evident from the catches of all maritime States. The trends of crustacean landings in the various maritime States are shown in Appendix 39.4 (Statements I to XI). Over 50 per cent of the all-India landings of the penaeid prawns are obtained from Kerala where enormous increase in production has been noticed in recent years. The penaeid prawn catches in the year 1973 were exceptionally high in almost all the States except Maharashtra and Tamil Nadu. Similarly non-penaeid prawn catches were also high in that year. The gradual decreasing trend of landings in respect of both these items seen in recent years in Maharashtra is specially noteworthy.

39.2.9 The relative increase of penaeid prawns and the decrease of non-penaeid prawns in Gujarat are possibly the result of introduction of mechanised trawlers which generally operate in deeper waters.

Increasing trend of production of both these items was noticed in Maharashtra till 1972 and thereafter the catch decreased considerably. In Goa the fishery is mostly for penaeid prawns and is mainly carried out by trawlers which have been introduced recently. The average annual catch is of the order of 700 tonnes. The principal prawn fishery off Karnataka coast, is of the penaeid prawns. The catch of penaeid prawns and other crustaceans has been steadily increasing in this State and this is mainly due to the introduction of mechanised boats in the capture fishery. The percentage of crustaceans in the overall catch of the State has increased considerably in recent years indicating a shift in the importance of this fishery over the well established pelagic fisheries of the State. Kerala has become the highest prawn producing State of the country in 1973 but in the subsequent year it has again yielded this position to Maharashtra. Significant increase in the catches of all the three categories of crustaceans has been noticed in this State in recent years. In the Pondicherry region the prawn catch decreased drastically and this is partly due to the shifting of the trawlers from this area to the adjoining bases in Tamil Nadu due to logistic reasons. The crab and lobster catch of the area remained steady.

39.2.10 Although of lesser magnitude the penaeid prawns are more uniformly distributed all along the east coast in Tamil Nadu and the catch has increased substantially during recent years. The non-penaeid prawn catch in this State was generally erratic but the lobster and crab catch has increased considerably. Increased operation of the mechanised boats in this State has resulted in this development. In addition, the large scale introduction of gill net operations in the Tirunelveli coast for large sized prawns (*Penaeus indicus and P. semisulcatus*) has also resulted in higher catches. The emergence of Tirunelveli coast and Mandapam regions as important prawn fishing regions has taken place during recent years. In Andhra Pradesh there was overall progress and the catches of all the three categories of crustaceans have increased in recent years. In West Bengal—Orissa region there has not been significant change in the structure of crustacean fisheries landings although some increase in the catches of non-penaeid prawns and other crustaceans is noticed. Crustacean fishery in the Union Territories of Lakshadweep and Andamans is now not significant.

Biology

39.2.11 The prawn fishery in India is seasonal, but seasons vary from place to place and also are influenced by the biological characteristics of different species. Generally speaking, the main fishing season extend from September to June on the west coast and from December to August on the east coast, in both the cases interruptions of the season being brought about by the prevailing monsoon on that coast. In the Gulf of Kutch and in central Kerala (mud bank fishery) a monsoon fishery for prawns is also in existence. From the open estuaries and backwaters prawns are landed throughout the year except during monsoon floods.

39.2.12 The individual species in the fishery have their own pattern of recruitment and it is quite possible that this may vary from place to place along the extensive coastline on east and west coasts. Most of these species breed in the coastal waters beyond the fishing areas of the traditional crafts. Sexually ripe prawns belonging to the exploited species have been obtained off Cochin in 20 to 60m depths. It has been possible to get the prawns brought in this condition spawn in the laboratory. In the natural condition spawning occurs nearly all the year round with specific peak periods. The eggs are semi buoyant and demersal, and the larvae pelagic. The late larval stages enter the estuaries and backwaters. Post-larval stages are generally obtained from the estuaries which act as nurseries for juveniles to feed and grow. After 4 to 10 months (varying from species to species) they leave the estuary and return to the sea. Sexual maturity is normally attained only in the sea. Although this is the general pattern, some species like *P. stylifera* do not enter estuaries, but spend their juvenile stage in the inshore waters. The commercial fishery of the estuaries and backwaters is supported by O-year class juveniles and that of the sea by O- and I-year classes.

39.2.13 The pattern of movement of penaeid prawns in the fishing grounds along the southwest coast is found to be size oriented. Soon after the southwest monsoon large-sized prawns are seen to move into 10 to 15 fathoms depth range. This movement from the deeper water is a sort of recolonisation of the grounds, the prawns having previously deserted the grounds probably due to the physico-chemical changes brought about by the southwest monsoon. The prevailing upwelling in the region during monsoon is believed to drive all the species of prawns except *M. dobsoni* into the deeper waters.

39.2.14 The results of the tagging experiments conducted at Goa, Cochin and Madras indicate that the movement of prawns is generally restricted within the fishing ground itself although an instance of their movements upto 60 km in 10 days time has also been reported.

39.2.15 The depthwise distribution of prawns as observed from the operations of the various exploratory vessels at three depth zones namely 0-40 m, 41-80 m and 81 m and above shows considerable variance. In the Kutch region less than 40 kg/hr of prawn in 0-40m depth zone and less than 10 kg/hr in 41-80m depth area are observed. In the Veraval-Cambay region the catch of prawns is extremely variable, between 2.8 kg/hr and 66.9 kg/hr. The bull trawlers working in the same region landed 4.9 kg/hr from the deeper zone. In general, higher abundance of prawns in the Bombay-Saurashtra waters is found along 20 fathom line (36m). Off Ratnagiri, the Government of India vessels landed prawns at the rate of 2.6 kg/hr from shallow waters. Along Karnataka coast prawn catches are relatively higher in the southern areas, catch rate being 5.7 kg/hr at Karwar and 18.7 kg/hr at Mangalore, both from the shallower areas. Prawns are rarely encountered in deeper regions.

39.2.16 Depending on the seasons, extremely variable catch rates have been recorded from different areas off the Kerala coast. It has been found that the maximum return of prawns has been taken from 7 to 20 m depth zones (50.0 kg/hr) which gradually declines to less than 5 kg/hr in the 37—42 m depth zones and to insignificant levels towards further depths. The knowledge of prawns in the deeper regions in this area is essentially from the operations of the Indo-Norwegian project vessels and of the Research Vessel 'Varuna'. It is generally found that areas off Kerala coast beyond 60 to 110 m depth are beset with rocky patches and hence not suitable for trawling operations for prawns. The occasional trawling operations in certain grounds of this region by R/V Varuna have brought very small quantities of prawns.

39.2.17 A significant discovery made during these years is the location of rich grounds along the continental slope of southwest coast of India for deep water prawns, hitherto unknown from the region. The extent of this ground is estimated to be about 5,000 sq km and the potential resource over 5,300 tonnes per year. The average catch rate recorded is 120.3 kg/hr using trawl nets with 35 to 47 m head rope.

39.2.18 On the east coast information on the prawn population from the deeper grounds greater than 40 m depth is scanty. On Tamil Nadu coast the operations of mechanised vessels are generally within 40m depth and the catch rate varies between 5 and 20 kg/hr. The results of the exploratory vessels based at Vishakapatnam show that relatively better catches of prawns are obtained from 41—80m depth region, the catch rate being 39.0 to 73.0 kg/hr. In the shallow regions below 40m depth the catch rate is only 3.0 to 4.5 kg/hr. At depths greater than 80m the effort and catch have been poor. Operations of the exploratory vessels off Gopalapore show a catch rate of 5.0 to 20.0 kg/hr in 40m depth zone and off Sandheads 5.0 to 10.0 kg/hr.

39.2.19 Detailed information on the depthwise distribution of prawns is essential for judicious exploitation of the stock. The results so far obtained are patchy and leave much to be desired. This is because of the fact that the operations of these vessels were not strictly exploratory in character and were often dictated by other considerations. In spite of the developments that have taken place in the industry no effort has been made to make a national programme of prawn resources survey by using the existing facilities. The ICAR coordinated project on marine prawn biology and resources aimed at only a qualitative work and was in existence for a brief period of 2½years only. The present need is to obtain year round quantitative information of prawns in all the fishable areas around the country. Such a survey can be conducted by making use of the existing vessels under the Government agencies. It is recommended that this should be given top priority.

39.2.20 As the life history of prawns is completed in two different biological environments, their capture in each of these environments is bound to affect the fishery of the other. The commercial fishery for prawns has been in existence in both these environments for a long time. The general biology of the prawns is characterised by high fecundity, fast rate of growth, continuous breeding and short span of life. Therefore, the nature of the fishery is somewhat like that of an annual crop, the success or failure of which is largely determined by the strength of recruits from the successive spawning. Under these circumstances, the wide fluctuations observed in the catches in certain years in some of the regions can only be due to fishery independent factors mentioned above. Due to the same reasons, the apprehension expressed about the depletionary tendencies in prawn fishery does not seem to be well founded.

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Estimating Catches

39.2.21 A detailed estimate of the stock of prawns in the Kerala region has been made based on indirect estimate of effort using the data of the exploratory vessels. This estimate has shown that the fishing effort in this region has come to a level from where further increase is not considered desirable. The catch per unit effort in this region has been showing decreasing tendency while the total catch from the region generally remained static. Under such situation further increase in fishing effort in this area is only likely to reduce the catch per unit effort.

39.2.22 In order to assess the effect of exploitation on the available stock it is necessary to have accurate data on the catch and the related effort in each given area. The shrimp trawlers use trawl nets of varying sizes. Similarly the catches obtained by the indigenous crafts are also not strictly comparable in terms of effort. For accurate assessment of the situation strictly comparable data on the catch are necessary. Efforts should therefore be made to collect comparable data for the purpose of such computations.

39.2.23 The present catch statistics in the country are computed on a gross basis giving details of the catch of the composite groups of penaeid prawns and non-penaeid prawns. These data, while useful for commmercial and management purposes are not suitable for dynamic computations, in order to study the effects of exploitation on the stocks. For this purpose it is necessary to obtain data on the landings of the major species separately. The CMFRI should take steps to collect these data separately for the major exploited species.

Resources

39.2.24 Exploited crustacean resources of the country is at present about 183,000 tonnes. Although there are various projections made on the exploitable resources many of them appear to be subjective. Taking into consideration the rate of exploitation in different centres, the available areas for expansion of fishing activity and the trends in the capture fishery a 2-3 fold increase from the present level of catch is considered justified. By judicious development of capture fishery and by extension of the same into new fishing grounds it would be possible to obtain an overall crustacean catch of 400 to 500 thousand tonnes per year.

39.2.25 Estuarine fishery: That the life history of prawn is completed in two different biological environments namely the sea and the estuarines is well known. The estuaries of India support juvenile prawn fishery of considerable magnitude and in areas like Kerala and West Bengal the juvenile prawn fishery of the estuaries is a significant vocation of the local people. Besides large areas impounded along the banks of estuaries are used for traditional prawn culture. This system is practised over vast areas in Kerala region. The catch statistics of the crustacean fishery computed by the CMFRI do not include landings obtained through these efforts. The juvenile prawn fishery is quite considerable and it is necessary to have a full estimate of the catches landed by these efforts. The CMFRI should develop a suitable system for the collection of these data also. This is highly essential to understand the prawn resources in the proper perspective for management purposes.

Culture of Brackishwater Prawns

39.2.26 The prawn processing industry and export trade of the country have been making rapid strides during recent years with the result that keen competition is felt by the industrialists in the matter of procurement of raw material which is solely provided by the capture fishery. At least in some of the centres, particularly the south-west coast of India, the capture fishery has become so intense that it is considered unprofitable to introduce new fishing effort. Under the circumstances increase of catch can be brought about only by exploitation of areas hitherto unexplored and also through culture. The need for exploration of new grounds has already been stressed.

39.2.27 The scope for prawn culture in the country is very vast. The major species of prawns available in the country are suitable for cultivation in the brackishwater areas. It is estimated that about 8,000 sq km of brackishwater areas available on the coastal regions of India can be brought under effective prawn cultivation. These areas being in rural surroundings, the development of prawn cultivation in such places may be taken up in cooperation with local self government agencies. The establishment of model farms in different localities and undertaking of extension work will create the appropriate climate for prawn cultivation. Steps should be taken to provide institutional finance for similar schemes. As these schemes are associated with the development of the rural economy top priority should be given for these.

Freshwater Prawns

39.2.28 Some of the fresh water prawns are endemic in the river systems of the country. They are exploited commercially in regions of West Bengal, Andhra Pradesh, Kerala, Maharashtra and Gujarat. This fishery which is mostly centred round *Macrobrachium rosenbergii, M. malcolmsoni and M. idella* is of a minor character. But it is well known that they are excellent species for culture in freshwater lakes. Even though they are freshwater forms they require saline regions for their breeding and larval survival. Efforts to culture them in rural areas should be encouraged.

Management

39.2.29 In recent years the prawn fishery of the country has developed into a big business and several industries have been established around it. The capture fishery has progressed from the level of a subsistence fishery to the status of an organised industry. At present there are no laws in the country to govern the activities associated with this industry. It is well known that unrestricted indulgence in the exploitation of any natural resource will lead to serious consequences. It is, therefore, necessary to control these activities through licensing of effort and control of size of species caught.

39.2.30 The Indian Fisheries Act of 1897 was passed at a time when fishing activity in the country was very insignificant and when the fishing industry was non-existent. No statutory provisions have been made even after the country has achieved Independence. Since the passage of Indian Fisheries Act enormous developments have taken place in the exploitation of this national resource and several industries have sprung up. These activities are not brought under legislation and it is highly necessary to enact a new fisheries act in the country to cover all aspects of fisheries activities and ancillary industries on an all-India basis. Although applicable to all fisheries, the need for enabling legislation is most essential for prawn fisheries. State Fisheries Organisations should institute a system of categorising and registering fishing boats undertaking prawn fishing with reference to operational bases and areas of fishing.

39.2.31 Exploitation of the national fishery resources is at present an uncontrolled activity. Introduction of new fishing boats into the capture fishery is taking place indiscriminately at all levels and vities. Even the registration of boats is at present a matter of option. there is no authority to consider the national usefulness of such acti- This is highly detrimental to the sustained exploitation of stock. In prawn fishery the pressure of exploitation is very high in certain regions. This situation can be tackled only by introduction of regulatory measures. We recommend that suitable regulatory measures should be introduced in appropriate areas to protect the stock which should be regularly monitored by the CMFRI.

39.2.32 The uneven distribution of prawn fisheries along the coast of India is chiefly brought about by the distribution of infrastructure facilities available in certain areas principally centered around ports and harbours. Basic infrastructure facilities may be made available in all important centres so that the fishing industry will be spread out all over the country. We have made similar recommendations on fishing harbours in Chapter 38 on Marine Fisheries.

39.2.33 The exploitation and utilisation of this national resource is to be viewed from two different perspectives, namely, (a) for the purpose of export to earn valuable foreign exchange and (b) for providing high quality food for the people of the country. The quantity of prawn processed and exported accounts for 60 per cent of the penaeid prawns landed. Forty per cent of this category and the entire quantity of non-penaeid prawns together amounting to about 90,000 tonnes are used within the country. The distribution and marketing of this for the people within the country have not developed on modern lines. CIFT should take up this problem seriously for processing smaller prawns for export and for internal consumption.

39.2.34 A number of industrial products such as Chitosan, peptone, etc. have been developed in the laboratory from shell wastes. These products should be prepared on an industrial basis to enhance the utility of prawns and the economy of prawn fishing.

39.2.35 One of the serious impediments voiced by the prawn industrialists for the development of capture fishery in the country is the lack of finance for import of trawlers and for the manufacture of the trawlers indigenously. Separate financing arrangements and incentives should be provided for obviating this difficulty as is being done by the Marine Products Exports Development Authority. Material and machinery required for processing and packaging of prawns should be made available to the industry on a priority basis so that the products from India can stand the stiff competition experienced in the foreign markets.

Deep Water Prawns

39.2.36 The exploratory trawling operations carried out from 1964 onwards by the vessels of the various Central Government agencies in deeper regions of the southwest coast of India have shown the occurrence of commercial concentrations of deep water prawns. The species concerned Append 39.2 are quite different from the littoral forms exploited from the coastal regions. They are distributed on the continental slope regions between 120 to 430 m depth. The area of their occurrence is very restricted and trawling for the same is possible only with powerful equipment and larger vessels. They are more predominant in the plateau-like region of the continental slope lying off Quilon. This area which is often referred to as Quilon bank is about 5,000 sq km in extent and has an average depth of 380 m. The annual exploited resource of this area estimated by applying 'swept area method' is 5,300 tonnes per year. In addition to this area the results of exploratory work indicate that these deep water prawns are fairly well distributed all along the continental slope of the west coast and in some regions of the east coast. Some of the species of deep water prawns are relatively large sized but the bulk of the catches is constituted by Pandalids which are relatively small. The meat of these prawns has better taste, flavour and consumer-appeal.

39.2.37 Exploratory work for deep water prawns has not been carried out systematically and it is of paramount importance that this resource is fully and rationally exploited. We, therefore, recommend that systematic exploratory work should be conducted making use of suitable exploratory vessels now available with the various Government agencies. Data on this from the east coast regions is very scanty and it is necessary to give some priority for this exploratory work there specially because of operation of foreign interest in the area.

3 LOBSTERS

39.3.1 India has a lobster fishery of considerable magnitude and it is chiefly constituted by spiny lobsters belonging to the genus *Panilurus*. It has sustained an export trade which commenced in 1962 with the export of 40 tonnes of lobster tails valued at Rs. 2.2 lakhs to the USA. The present export of lobster tails amounts to 460 tonnes valued at Rs. 1.25 crores. The lobster fishery of the country is confined to the littoral regions having rocky substratum. Therefore they are distributed in discontinuous regions and the populations sustained by these regions are perhaps independent of each other. Production of spiny lobsters is about 1,500 tonnes a year. This is small when compared with the lobster production of the chief lobster producing countries like South Africa and Australia, where the annual catches amount to 80,000 tonnes and 12,700 tonnes respectively. Production of spiny lobsters in Japan amounts to 1,300 tonnes. In view of the recent developments of lobster fishery particularly on the southeast coast of India, it is obvious that there is scope for increased exploitation in some regions, whereas in regions of conventionally exploited areas namely Kanyakumari district on the southwest coast there are signs of over exploitation. In view of the fact that the spiny lobsters are found on rocky regions of the coastline in isolated areas the expansion of its fishery in the conventional grounds is not likely to enhance the catch. Increase of catch can only be expected from new areas and as such the overall increase can only be marginal. The exploitable resource of spiny lobsters may therefore be around 2,000 tonnes.

39.3.2 In order to maintain the fishery of spiny lobsters with maximum advantage it is necessary to extend this fishery to non-conventional areas by finding new resources. It is, therefore, suggested that investigations should be conducted by CMFRI in coordination with CIFT for locating lobster grounds and finding out suitable types of gear and selective baits for expanding fishing effort for lobsters with a view to increasing their production for export purposes. It is equally important to protect the lobster fishery of the conventional regions by introducing suitable regulatory measures. As India's lobster fisheries are restricted to widely separated and confined areas, over-exploitation can lead to disastrous consequences. In all the countries of the world where spiny lobsters are exploited commercially, fishing operations are controlled and regulated by laws such as legal minimum size, restricted fishing seasons, banning of certain destructive capture methods etc. We recommmend that immediate action should be taken by the State fisheries organisations to control the exploitation of lobster fishery particularly from the southwest coast of India where signs of over exploitation are already evident.

39.3.3 Deep water lobsters : The exploratory trawling operations conducted by the Indo-Norwegian project vessels in 1967 have shown that large concentrations of the deep water lobster *Puerulus sewelli* Ramadan exist in the upper continental slope of the west coast of India. They were obtained in high concentrations in 200m depth regions in trawl nets. Perhaps this is the only instance of commercial exploitation of spiny lobster fishery by using trawl nets. This fishery which is now known to exist on the shelf regions off Calicut on the west to Gulf of Mannar on the east coast. Catches are seasonal and last from November to February. Accurate assessment of the resources is not available; nevertheless its prospective development into a commercial fishery in the coming years is very bright. Perhaps continued exploratory work will provide details. In view of the high price and demand for lobsters in the world market it is essential that this fishery is brought on a systematic footing. We recommend that detailed exploratory work on the resources of deep spiny lobsters be undertaken by the CMFRI.

4 CRABS

39.4.1 Crab fishery of the country is quite substantial although it is often referred to as a subsistence fishery of the coastal fishermen. The fishery is presently supported by two species of marine edible crabs namely *portunus sanquinolentus* (Herbst) and *Portunus peleqicus* (Linn) and one estuarine species *Scylla serrata* (Forskal). In the marine catch statistics of the country crabs are included under the head 'other crustaceans'. This group consists of crabs and lobsters only. Marine crab landings of the country are estimated to be around 10,000 tonnes a year and the catch trend indicates increased production. The marine crabs are generally obtained in the trawler catches along with other demersal species and they are virtually incidental in the trawling operations for prawns. The two species of portunids generally fished are (a) small sized crabs having relatively low quantity of meet and (b) the estuarine species *Scylla serrata* which is a large growing species and has more meat. Small quantities of frozen crab meat have been exported in earlier years but there was no development of the trade which came to a halt in 1968. In 1972 export of canned crab meat was resumed and this trade has shown tendencies of development and in 1974, 13.7 tonnes of canned crab meat, valued at over Rs. 5 lakhs was exported. There are prospects for further development of this trade. Regarding the estuarine crab fishery there is no definite estimate but it is well known that large quantities of estuarine crabs are fished and marketed from Pulicat and Chilka lakes and deltaic areas of Krishna, Godavari and also from the brackish areas of Kerala and West Bengal.

39.4.2 Since the crab fishery is only an incidental catch of trawler operations there is no special effort made for their capture. Study of the resources and their further development is called for. Similarly there is vast scope for the development of estuarine crab fishery because *Scylla serrata* (Forskal) is a cultivable species. Steps should therefore be taken by the CMFRI and CIFRI to culture them on a commercial scale. This should be preceded by a pilot project in selected areas. Based on the catch data obtained from different coastal regions of the country and from the brackish water region potential resource of 44,000 tonnes per year is estimated. This means a 5 fold increase from the existing catches.

39.4.3 In addition to these resources deep water exploratory cruises of the Indian Ocean Expedition have indicated the existence of large quantities of deep water crabs in the oceanic waters of the west coast of India. The most common species encountered are *Charybdis (Goniohellenus) edwardsi* and *Homola megalops*. Huge swarms of these crabs are reported from the western Indian ocean region. Although these crabs have very little meat, their occurrence in enormous quantities offers possibilities for eventual use in feed stock industries and can profitably supplement fish meal.

5 SQUILLA

39.5.1 In addition to the conventional species exploited in the country there are some other crustaceans which are observed in large quantities but are seldom utilised or recorded. The mantis shrimp is one such item. Throughout the west coast of India trawling operations for prawns commence after the monsoon, in the month of September. The trawling grounds at this time are generally inhabited by squilla and they form a menace to the regular fishery. Often a day's catches of a single mechanised boat will take more than a tonne of squilla. They are generally separated from prawns and thrown back into the sea. Recently these boats have started to bring them ashore and to have them reduced as manure by crude processes. There are no statistics relating to the occurrence of this unutilised crustacean.

But from the magnitude and period of their occurrence in the trawl catches a gross landing of over 50,000 tonnes can be estimated. If proper reduction facilities are made available this will provide a good source of high quality protein and a raw material for the industrial product chitosan. The principal species are *Oratosquilla nepa* (Latreille) and *O. holoschista* (Kemp). Both these species are not considered edible at present perhaps because of the very scarce meat content in them. Another species of squilla, *Harpiosquilla raphidia* (Fabricius) is a large growing species often occurring in the inshore catches of the Maharashtra region and the northeast coast. They have no commercial value.

39.5.2 The quantity of squilla landed or which can be landed in the course of the present range of fishing operations is so high that it is difficult to ignore it in a developing system. We recommend that efforts must be made to utilise this resource and also to obtain detailed information about its magnitude. This would involve resource studies and technological research which should be undertaken by the CMFRI and CIFT.

6 UTILISATION

39.6.1 The pattern of utilisation of the prawns has undergone significant changes in the past 20 years as a result of political and technological developments. The traditional export trade of prawn pulp and dried prawns to Burma and other eastern countries began declining soon after Independence and its place has been taken up by a lucrative export trade of sophisticated products such as frozen and canned prawns to many countries of the world but mainly to Japan and the USA. The export of frozen prawns which commenced in a humble way in 1953 has had a rapid growth (Appendix 39.5) and today it is the mainstay of the export trade of marine products from the country.

39.6.2 In the course of development of this export trade different products have been prepared out of prawn and attempts are made to diversify the products for export. The principal methods of utilisation of crustaceans in the country are given in Appendix 39.6.

39.6.3 Figures for the items of export are available, but there are no precise data relating to the nature of utilisation of prawns consumed within the country. By calculating backwards from the export figure on the basis of percentage recovery of finished goods it is seen that a little over 60 per cent of the wet weight of penaeid prawns has been processed for export in 1974.

39.6.4 It is a matter of consequence to note that the processing of prawns in India for export is entirely based on the large sized prawns of the penaeid group. The smaller sized prawns belonging to the non-penaeid group (which form about 40 per cent of the all-India catches) are not exported in any form. The volume of production of this group of prawns is so great that it is hightime that they are processed for export. At present they are mostly sun-dried and marketed in the internal markets. These prawns are ideal for making prawn powder or prawn paste which are prized as food seasoning materials.

Frozen Prawn Industry

39.6.5 While the utilization of the crustaceans in the country is of a diverse nature all the attention of the industry is centred around the processing industry which handles prawns for export. Frozen prawn is the most important of the exported items although there are many other products which are exported from the country. Examination of the statistics of export of marine products shows that products emanating from the crustaceans account for over 80 per cent in terms of weight and over 90 per cent in terms of value of the total export of marine products. It is, thus, clear that the various problems of the marine products export industry are virtually synonymous with those of crustaceans.

39.6.6 The most important problem faced by the industry is the availability of raw material for processing and the keen competition between the exporters to procure it. This is partly due to the unduly concentrated fishing effort in certain localities like Cochin and partly due to inadequate transport facilities from remote production centres. The remedy for this situation is in the increased production of exportable variety of prawns and by the provision of quick means of transport. Decentralization of the infrastructure will also enhance production for export.

39.6.7 Generally speaking undue dependence of the sea food industry on prawns is not desirable and it will be in the national interest to diversify the export items by finding out good foreign markets for items like mackerel, sardines, etc.

39.6.8 Just as the industry is centred around prawns, the export market is largely confined to USA and Japan which account for bulk of the exports of these products from India. This extreme restriction of the export market is undesirable as the industry is unduly exposed to the trade, social and political conditions of the receiving countries. It is, therefore, necessary to diversify the exports to other countries as well.

39.6.9 Most of the products are now sent in bulk consignments and the receiving countries either repack or use them for manufacture of consumer products. It is always best to have the products marketed under Indian labels and this can be done only if consumer packs are prepared. Efforts should be made to develop materials and equipment such as liquid nitrogen etc. for the preparation of consumer packs.

39.6.10 Generally speaking consumer appeal for Indian prawns is relatively low as compared to those exported from Indonesia. Australia, Persian Gulf, etc. This is due to the poor handling of the raw material. It is necessary to give special attention to prawns meant for export. Introduction of a system of beheading them as soon as they are landed on the deck of the trawlers and storing them in appropriate containers will improve the quality of the product. Also it would be necessary to introduce mechanical handling system in places of unloading from the ship and from the factories.

39.6.11 Infrastructure required for processing of prawns is at present concentrated in certain areas particularly in Kerala where consignments of prawns are received even from as distant places as Orissa. In some other regions freezing and processing facilities are inadequate. Availability of harbour facilities for the mechanised boats engaged in capture fishery is the main reason for this localised concentration of infrastructure. Generally speaking infrastructure facilities in the east coast are poor. Provision of better harbour facilities in the east coast regions will go a long way towards enhancement of the capture fishery in those regions.

39.6.12 Although catch data of different kinds of vessels working in different areas of the coast are available for the use of industrialists and management experts there is practically no information on the commercial aspects such as the cost involved in operating specific types of boats in known regions. The lack of such information is a serious impediment as new entrepreneurs find it difficult to assess the feasibility of the commercial operations. It is also necessary to have these commercial data to help the financing institutions to evaluate project reports

7 RESEARCH

39.7.1 Qualitative and general information on the biology of the exploited species of prawns, lobsters and crabs of the country is fairly well documented by the CMFRI. But there are a number of specific problems such as survival rate, mortality, pattern of recruitment, migratory pattern and behaviour, physiological conditions, etc. which require detailed studies. While recommending the need for intensified research on these lines stress is laid on the urgency of the need of information on the migratory pattern of the exploited species. The mark-recovery experiments conducted by the CMFRI have provided preliminary information about some species of prawns and lobsters, but these have to be intensified and carried out from a large number of centres on both the coasts of India. If necessary a special programme may be drawn up and executed on a time bound basis.

39.7.2 It is well known that the prawns complete their life-history in two environments—the sea and the estuaries—each having divergent physical, chemical and biological characteristics. The physiological characteristics and capacities of adjustments to the changing environments inherent within the body of the prawns, which make it possible for them to freely move from the estuaries to the sea is not fully known. While some basic information on the osmoregulatory mechanism of these animals is available, considerable work has to be undertaken for giving a full explanation of migratory behaviour of the prawns. This background information will be necessary to formulate policies of better utilisation of the resource. Institutions and laboratories in India have not been devoting much attention to this aspect of work chiefly because of the specialised nature of the work and due to lack of field and laboratory facilities. The work of this nature has to be carried out in a full-fledged laboratory with all facilities of control conditions of environmental parametres. Work on the crustacean endocrinology has been a neglected field as such the initiation of this field has to be given a serious thought. Specialised workers in both the fields of experimental ecology and physiology are very few in the country. These are aspects which should receive attention from the ICAR.

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39.7.3 Considerable work has been done by different workers on the food and feeding habits of prawns but most of these relate to the description of what is observed by them in the gut contents of dead prawns. In the changing situation particularly in the context of introduction of large scale prawn culture in the country, studies on the feeding habits of the culturable species call for special attention. Developing artificial prawn feed is an urgent need, and this can be accomplished only if detailed data on the feeding habits of different species of prawns are available. Besides it is necessary to find out details of the pattern of food assimilation and the conversion rate of the food offered in terms of the body-weight gained. Also efforts should be made to compound and patent cheap prawn feed using readily available waste products of other industries for the use of prawn culturists. There should be a proper control over the quality of the number of patented feeds that are likely to come up when the prawn culture becomes a widespread rural practice. Therefore we recommend that food and feeding studies of prawns in the new perspective should be given high priority.

39.7.4 Development of prawn culture will require elaborate arrangements to provide seedprawn to the culturists in large quantities through proper agencies. The seedprawn can be made available from two sources namely (a) by collecting from natural sources and (b) from the production of seed from artificial spawning in hatcheries. The CMFRI has reported methods of collection of seedprawn (post-larvae) from the surf regions of the sea. A proper survey of the seedprawn resources along the country may be carried out and experiments may be undertaken on the transport of seedprawn to distant places. It is now known that if proper spawners are available prawns can be made to spawn under controlled conditions. Considerable portion of the seedprawn requirement of the culturists will have to be met from this source. Arrangements may be made to establish seedprawn hatcheries in different parts of the country. Experiments on important commercial species should be carried out to induce their growth and breeding in captivity.

39.7.5 One of the serious problems in the matter of production of seedprawn from the artificial spawning is the proper food for rearing the zoea upto the post-larva stage. Substitutes for the monoculture of Skeletonema and the brine shrimp eggs may be found out. The recent experiments of the CMFRI in feeding the zoeal stages with mass culture of *Thalassiocera* show good prospects. Work on these aspects must be intensified.

39.7.6 Ecological studies relating to prawn have to be undertaken in greater detail so that necessary prefarming information becomes available within a short time.

39.7.7 In the matter of capture fishery a regular monitoring of the effects of exploitation on stock has to be carried out from different centres of the country and the information thus obtained has to be quickly disseminated to the industry and to the Government agencies. These data are essential for formulating timely management policies regarding the exploitation.

39.7.8 The crustaceans as a group in general, and prawns in particular, constitute the most important commercial fishery from the standpoint of both, capture and culture aspects in the resources of fresh, brackish and sea waters.[1] Biologically the crustacea are widely different from true fishes constituting the conventional fisheries and require special research and study. This should be recognised in the programmes of research by ICAR. Research on the most important section of this group, i.e. prawns, is being partly conducted at CIFRI and partly at CMFRI. Not only is there a need for considerable intensification of research on this group as a whole but there is also an urgent need for undertaking well co-ordinated research programmes on an all-India basis. A separate research division for the crustacean group should be constituted. This should form a nucleus which should develop in course of time into a separate Crustacean Research Institute, as the research work progresses.

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[1] 1968. Proceeding of the World Scientific Conference on the Biology and Culture of Shrimps and Prawns. FAO Fisheries Reports No. 57, Vol. 1-5.

8 GENERAL SUGGESTIONS

39.8.1 Research on the prawn fisheries of the country is now being carried out by the ICAR research institutes, and marine biological departments of some of the conventional universities. The bulk of the problems relating to capture fishery, culture fishery and technology of processing are handled by the ICAR Research Institutes namely CMFRI, CIFRI, and CIFT. The basic field data required for detailed analysis and research are obtained by these institutes with the co-operation and assistance of the commercial fishery organizations and the Government of India fishing agencies. With the transfer of the three institutes mentioned above to the ICAR in 1967 the institutional co-operation between them and the agencies directly functioning under the Ministry has become somewhat ineffective. Coordination between these institutions is absolutely essential for productive research and it would be in the best interest of exploitation, management research utilisation and trade to bring all these activities under a unified top level direction without the decision making getting fragmented in different Ministries and departments of the same Ministry. We feel that a high level machinery for this purpose may be set up at least for the prawn fishery.

39.8.2 Emergence of a modern capture fishery for prawns and related export trade was the most significant development that has taken place in the field of exploitation of marine fisheries of the country during the past twenty years. In the course of exploitation of prawns in different areas serious conflicts between those engaged in the exploitation inshore and offshore regions have occurred. In fact such conflicts have led to destruction of several fishing crafts and properties in some parts of the country particularly in the Tirunelveli district of Tamil Nadu. It is necessary to end these conflicts by introducing proper legal provisions based on management requirements. A clear cut delineation of the inshore and offshore fishermen and their spheres of activity is called for. We have made recommendations on this aspect separately in the Chapter 38 on Marine Fisheries.

39.8.3 We are convinced that in the export trade of prawns and other marine products, there is room for both the small entrepreneur and the larger business houses which can be categorised into three district categories: (a) the fishermen or the primary producers who should be encouraged to form cooperative societies for marketing the catch and to organise small scale processing plants; (b) the small scale entrepreneurs who primarily buy the prawn landings from the fishermen, process it and export it; and (c) the larger business houses who have recently entered the industry.

39.8.4 As regards the fishermen, they should be assisted by every reasonable means to increase the catches and raise the productivity. The mechanised vessels suitable for prawn fishing viz. the 10 m category and the appropriate engine of 40 hp should be made available to them and to this end financial assistance by way of grants and loans should continue. It is here that mass assembly of a particular type can help reduce the construction cost. Cooperative societies can be formed by the fishermen to market their catches. If they are enterprising they can enter the export trade by processing the catches and shipping them as has been done by one of the large cooperative societies in Gujarat.

39.8.5 As regards the second category, they are essentially of the nature of middlemen but, it must be conceded that it is this particular category of smaller entrepreneurs who have developed the shrimp industry of India to what it is today. Frozen prawn industry would never have grown but for them and it is this group that has assured a higher return to the prawn fishermen. Their organisation and enterprise has led to the search for markets, finding out avenues of export, foreign trade credit and a number of facilities. Both, the Fisheries Division of the Ministry of Agriculture and Irrigation and the Export Division of Ministry of Commerce, have no doubt given them assistance. Technical assistance provided by agencies like the Indo-Norwegian Project has been extremely useful. Success of a few has made many enter this business to the disadvantage of all i.e. they are all after the same amount of raw material. Only a few among them have invested in fishing themselves and increasing the landings of prawn. The few who come forward for actual fishing should be fully supported, financially and otherwise. Their processing operations being somewhat small-scale, they are apt to fall short of standards and should be rigidly inspected for quality.

39.8.6 The third category are the larger business houses who have entered fishing. A few are genuinely interested in the ventures and they have been in the field for many years; they now like to expand. Newcomers have thought this to be a profitable avenue when supported with experties. Some others have taken to fishing purely for diversification to secure tax benefits. In any case, the larger business houses can bring much organisational skill, and marketing competence to the industry. Only they can invest on large trawlers and large scale and up-to-date processing plants. They should be encouraged so that private investment on larger fishing vessels will take place and also higher organisational ability. Probably a higher standard in the processed product could also be expected. This category of parties should be allowed to enter the industry only if they obtain their own raw material for their processing plants, at least up to 50 per cent of their requirements. Otherwise they will again be buying from the existing raw material landed for which there is acute competition. Perhaps in course of time the limit of 50 per cent could be raised or reduced depending upon the extent of commercial fishing operations outside the big trawler sector. The limit should be subject to periodical review.

9 SUMMARY OF RECOMMENDATIONS

39.9.1 The following is a summary of the important recommendations made in this chapter.

1. Mechanised fishing vessels around 10 m length and 40 BHP are recommended for prawn fishing in coastal waters. These should be built on mass assembly basis. Boats with outboard motors are recommended for creek fishing. Prototypes of larger vessels for offshore operations should be imported and tried for selection of designs for large scale construction in Indian ship building yards.
(Paragraphs 39.2.5 and 39.2.6)

2. Immediate attention should be given by ICAR to the survey and assessment of marine prawn resources on all-India basis for rational exploitation in the areas under heavy fishing pressure and for finding out under-exploited and new areas.
(Paragraph 39.2.19)

3. The prawn fishery is multi-species in composition and operated by different types and sizes of gear. The CMFRI should work out statistical methods to compare the catch data by different gears, enabling detailed estimates on the landing of important prawn species for the marine prawn fishing centres of the country. Continuing data on catch per unit of fishing effort should be built up so that deleterious effect on fisheries could be diagnosed early. To enable reliable collection of data the CMFRI should bring out illustrated manuals for quick field identification of prawn species of commercial value. The capture fisheries of prawns should be regularly monitored by the CMFRI from different centres of the country to determine the effects of exploitation on stock. The information thus obtained

should be quickly disseminated to the industry and governmental agencies for regulatory action, if any.

(Paragraphs 39.2.21 to 39.2.23, 39.2.31 and 39.6.7)

4. Prawn fishery statistics collected by CMFRI institutes should include detailed catch data on estuarine prawns which are now left out.

(Paragraph 39.2.25)

5. Model prawn culture farms should be established in suitable brackishwater areas as extension centres.

(Paragraph 39.2.27)

6. In the context of prawn fisheries in particular, and fishing industry in general, the Indian Fisheries Act of 1897 should be replaced by a new legislation with necessary provisions for enforcing management and conservation measures. State fisheries organisations should institute a system of categorising and registering fishery boats undertaking prawn fishing with reference to operational bases and areas of fishing. Suitable regulatory measures should be introduced in appropriate areas to protect the stocks which should be regularly monitored by the CMFRI.

(Paragraphs 39.2.29 to 39.2.31)

7. The CIFT should evolve processing techniques for the non-penaeid prawns caught in large quantities along with penaeids for utilising them for export as well as for internal consumption.

(Paragraph 39.2.33)

8. The prawn waste obtained in processing plants should be utilised for the preparation of industrial products such as chitosan, peptone, etc.

(Paragraph 39.2.34)

9. Separate financing arrangement for import of trawlers and their indigenous manufacture should be made. Material and machinery for processing and packaging should be made available to the industry on priority basis.

(Paragraph 39.2.35)

10. Systematic resource survey and assessment of deep water prawns should be urgently carried out for early commercial exploitation of this resource.

(Paragraphs 39.2.36 and 39.2.37)

11. Investigations should be undertaken by CMFRI in coordination with CIFT for locating lobster grounds and finding out suitable types of gear and baits for expanding fishing effort for them with a view to increasing their production for export purposes.

(Paragraph 39.3.2)

12. State fisheries organisations, particularly of south-west, coast, should undertake necessary measures to control lobster fisheries wherever it is over-exploited.

(Paragraph 39.3.2)

13. Detailed exploratory work on the resources of deep sea spiny lobsters should be undertaken by the CMFRI and the restructured deep sea fishing organisation.

(Paragraph 39.3.3)

14. Culture of the crab, *Scylla serrate*, on pilot scale should be undertaken by the CMFRI and CIFRI in some select areas.

(Paragraph 39.4.2)

15. The CMFRI and CIFT should undertake the resource study of Squilla fishery and its utilisation since they constitute an appreciable quantity of the trawl catch which is now being discarded.

(Paragraphs 39.5.1 and 39.5.2)

16. There is an urgent need for diversification in the present trend of export of marine products. At present it is almost comprised of frozen prawn export from only a few centres in the country mostly to USA and Japan. This would involve the spread of fishing effort for prawns and development of necessary infrastructure to as many centres as possible and export of a variety of crustacean products to as many countries as possible.

(Paragraphs 39.6.1 to 39.6.3
and 39.6.5 to 39.6.8)

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17. Steps should be taken to bring about improvements in the processing sector for better quality products in smaller packs to avoid thawing, refreezing and re-packing in the importing countries. This commodity should, as far as possible be sold in the foreign markets under Indian trade labels. High standards for the products should be kept up by strict quality and inspection control.

(Paragraphs 39.6.9 and 30.6.10)

18. Owing to the importance of fundamental research on crustocea of commercial importance, field and laboratory facilities should be established with particular emphasis on endocrinology, ecology, physiology and fishery biology. Research work on the migratory movements of different species of prawns of commercial importance in estuaries and in the sea should be intensified. ICAR should give priority in fishery research programmes to all aspects of prawn culture to make it economically feasible.

(Paragraphs 39.7.1 to 39.7.6)

19. With considerable commercial importance of crustacea in both capture and culture fisheries of fresh, brackish and sea waters the ICAR should constitute a separate division for research on crustacea which in course of time could develop into an institute for crustacean research.

(Paragraph 39.7.8)

20. The Government should set up a high level machinery for taking decisions regarding the exploitation, management, research, technology and utilisation of crustacean resources and trade, instead of decision making being fragmented in different ministries and departments of the same Ministry.

(Paragraph 39.8.1)

21. The fishermen who are primary producers of prawns should be given financial support for boats and gear for increasing their production. They should be assisted to form cooperative marketing organisation.

(Paragraphs 39.8.3 and 39.8.4)

22. There is ample scope for both shall scale entrepreneurs and large business houses in the marine products trade and export industry. The large business houses should however be allowed to enter only on the basis of atleast 50 per cent of the raw material from their own operations for their processing plants.

(Paragraphs 39.8.2 to 39.8.6)

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APPENDIX 39.1

(Paragraph 39.1.1)

World Catch of Shrimps and Prawns

('000 tonnes)

Country	1970	1971	1972	1973
U.S.A. . . .	166.7	177.3	174.6	168.8
India	121.7	149.9	163.8	207.0
Mexico	69.1	71.5	74.9	72.7
Malaysia	48.7	57.7	59.6	64.6
Thailand	81.6	85.3	89.3	110.7
Vietnam . . .	33.3	45.8	54.2	62.0
Phillippines . . .	21.4	27.9	27.8	23.5
Pakistan . .	23.3	18.0	18.1	20.9
Brazil	35.3	36.4	36.4	36.4
Australia . . .	13.4	16.1	17.5	16.2
Japan	54.5	50.0	57.3	62.6
total . .	940.0	1,000.0	1,015.0	1,007.0

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APPENDIX 39.2

(Paragraphs 39.2.2 and 39.2.36)

Distribution of Prawns by Size in Commercial Fishery

(mm)

Species	Fresh water catch		Estuarine catch		Marine catch		Deep water catch	
	Size range	Modal size	Size range	Modal size	Size range	Modal size	Size range	Modal size
Penaeus indicus	..	..	20—140	81—90	101—230	131—175	..	..
P. merguiensis	..	..	11—130	51—90	101—230	131—170	..	..
P. monodon	..	..	21—150	101—140	121—300	131—200	..	..
P. semiculcatus	..	..	21—150	51—70	121—220	151—180	..	..
Metapenaeus dobsoni	..	..	16—80	41—60	61—130	81—110	..	..
M. affinis	..	..	16—120	31—50	31—180	71—95 116—170	..	..
M. monoceros	..	..	16—100	56—90	41—180	121—150	..	..
M. brevicornis	..	..	16—115	26—30	41—110	46—90	..	..
*M. kutchensis	..	..	16—110	31—50	31—160	71—90	..	..
Parapenaeopsis stylifera	..	..	..	..	16—145	61—115	..	..
*P. sculptilis	..	..	21—60	21—30	26—152	76—135	..	..
P. hardwickii	..	..	..	..	31—130	81—100	..	..
P. maxillipede	..	..	..	..	31—125	..	..	..
*P. acclivirostris	..	..	..	..	21—50	..	..	..
Solenocera indica	..	..	..	..	26—115	51—80	..	..
*Trachypenaeus curvirostris	..	..	..	..	26—95	..	..	..

Palaemon tenuipes	..	..	..	..	31—75	46—50	..	..
P. styliferus	..	..	30—90	46—65	16—100	51—70	..	..
Hippolysmata ensirostris	..	..	..	..	16—90	51—75	..	..
Acetes indicus	..	..	..	..	11—36	16—25	..	..
*A. cochinensis	..	..	..	..	11—20	..	..	..
*Aristeus semidentatus	..	..	..	..	..	..	70—190	146—150
*Solenocera hextii	..	..	..	..	..	..	75—115	91—95
*Penaeopsis rectacuta	..	..	..	..	..	..	70—130	86—90
*Metapenaeopsis and amaneasis	..	..	..	..	..	..	70—130	86—90
*Parapandalus spinipes	..	..	..	..	..	..	85—130	86—90
*Plesionika martia	..	..	..	..	..	..	75—130	96—100
*P. ensis	..	..	..	..	..	..	60—120	106—110
*Heterocarpus wood-masoni	..	..	..	..	..	..	75—135	116—120
*H. gibbosus	..	..	..	..	..	..	75—140	96—100
Macrobrachium rosenbergii	..	76—320	176—180	..	..	..	..	..
M. malcolmsonii	..	50—230	146—150	..	..	..	..	..
M. idella	..	50—110	86—90	..	..	..	..	..

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* Of minor commercial value only.

APPENDIX 39.3

(Paragraph 39.2.8)

Catch of Marine Crustaceans in India

(tonnes)

Year	Penaeid prawns	Non-Penaeid prawns	Other crustacean	Total crustaceans	Percentage of crustacean to total marine catch
1950	37,022	36,396	1,486	74,904	12.90
1951	37,972	37,302	1,523	76,797	14.38
1952	38,072	37,401	1,528	77,001	14.57
1953	44,839	44,049	1,799	90,687	15.59
1954	76,255	74,912	3,058	154,225	26.22
1955	52,720	51,792	2,114	106,626	17.89
1956	66,910	92,372	270	159,552	22.19
1957	74,648	61,374	791	136,813	15.62
1958	29,204	55,987	1,508	86,699	11.47
1959	27,632	37,805	2,093	67,530	11.55
1960	31,759	36,271	2,571	70,601	8.03
1961	39,083	23,685	2,038	64,806	9.48
1962	48,251	34,984	1,031	84,266	13.08
1963	41,071	40,522	2,061	83,654	12.76
1964	63,389	31,506	4,565	99,460	11.57
1965	38,085	41,415	2,365	81,865	9.93
1966	56,146	34,768	3,716	94,630	10.64
1967	63,310	31,112	5,261	99,683	11.18
1968	69,467	31,922	4,301	105,690	11.32
1969	72,133	33,964	5,670	111,767	12.23
1970	89,857	31,834	10,832	132,523	12.21
1971	73,320	76,648	9,592	159,560	13.73
1972	78,361	85,488	11,599	175,448	17.90
1973	136,938	66,955	12,556	216,449	17.71
1974	111,860	55,244	15,882	182,986	15.48

APPENDIX 39.4

(Paragraph 39.2.8)

Landings of Marine Crustaceans in Different States

Statement I—West Bengal and Orissa

(tonnes)

Year	Penaeid prawns	Non-Penaeid prawns	Total prawns	Other crustacean	Total marine catch
1960	803	..	803	3	5,532
1961	1,612	..	1,612	4	8,924
1962	2,178	27	2,205	..	7,948
1963	3,776	17	3,793	..	11,144
1964	2,309	..	2,309	8	10,642
1965	2,133	..	2,133	..	12,244
1966	1,885	..	1,885	2	10,041
1967	7,801	..	7,801	6	19,318
1968	10,872	..	10,872	..	30,658
1969	5,638	..	5,638	..	22,879
1970	2,994	22	3,016	3	31,403
1971	1,679	..	1,679	..	18,032
1972	1,400	..	1,400	3	15,330
1973	2,565	486	3,051	60	22,736
1974	2,466	1,165	3,631	45	26,597

Statement II—Andhra Pradesh

1960	1,591	1,003	2,594	1,423	56,720
1961	2,797	689	3,486	496	54,506
1962	1,305	374	1,679	213	60,027
1963	3,476	880	4,356	853	64,573
1964	5,224	1,205	6,429	467	71,727
1965	3,507	330	3,837	9	76,477
1966	2,999	626	3,625	162	80,087
1967	6,886	2,002	8,888	271	76,054
1968	5,784	342	6,126	159	77,429
1969	4,309	1,757	6,066	114	77,526
1970	5,004	1,886	6,890	97	74,459
1971	8,748	288	9,036	81	84,010
1972	4,866	437	5,303	243	84,480
1973	8,170	669	8,839	363	99,544
1974	8,957	2,842	11,799	934	158,818

APPENDIX 39.4 (contd.)

Statement III—Tamil Nadu

(tonnes)

Year	Penaeid prawns	Non-Penaeid prawns	Total prawns	Other Crustacean	Total catch
1960 . . .	1,872	275	2,147	823	107,810
1961 . . .	1,819	1,008	2,827	1,311	123,501
1962 . . .	2,526	10	2,536	755	111,435
1963 . . .	3,265	101	3,366	1,058	109,482
1964 . . .	3,955	145	4,100	3,982	131,309
1965 . . .	2,198	82	2,280	2,110	99,018
1966 . . .	5,136	123	5,259	2,443	134,779
1967 . . .	7,137	230	7,367	4,725	152,497
1968 . . .	6,159	734	6,893	3,863	154,400
1969 . . .	5,526	287	5,813	4,789	151,876
1970 . . .	4,724	540	5,264	4,420	155,516
1971 . . .	3,636	62	3,698	6,058	160,619
1972 . . .	4,843	148	4,991	9,515	155,153
1973 . . .	4,504	1,285	5,789	7,720	182,419
1974 . . .	8,060	46	8,106	9,752	175,713

Statement IV—Pondicherry

1960 . . .	..	..	..	..	..
1961 . . .	..	..	..	..	..
1962 . . .	..	..	..	..	..
1963 . . .	..	..	..	..	..
1964 . . .	..	..	..	..	..
1965 . . .	438	..	438	51	7,011
1966 . . .	1,019	..	1,019	279	12,762
1967 . . .	651	..	651	126	8,017
1968 . . .	589	..	589	71	8,151
1969 . . .	614	..	614	156	10,637
1970 . . .	447	..	447	92	10,624
1971 . . .	289	1	290	170	10,454
1972 . . .	177	5	182	408	8,980
1973 . . .	33	8	41	194	8,682
1974 . . .	27	2	29	201	7,698

APPENDIX 39.4—(*Contd.*)

Statement V—Kerala

(tonnes)

Year	Penaeid prawns	Non-Penaeid prawns	Total prawns	Other Crustacean	Total marine catch
1960	12,583	23	12,606	175	314,605
1961	20,393	43	20,436	105	267,493
1962	29,218	..	29,218	22	191,421
1963	21,878	76	21,954	90	202,330
1964	35,220	..	35,220	72	317,976
1965	14,327	84	14,411	130	339,173
1966	28,120	259	28,379	557	346,744
1967	27,164	88	27,252	58	364,129
1968	25,356	35	25,391	177	345,301
1969	34,334	34	34,368	435	294,787
1970	36,940	14	36,954	556	392,880
1971	31,294	1,519	32,813	523	445,347
1972	35,866	711	36,577	158	295,618
1973	84,770	981	85,751	1,781	448,269
1974	59,893	1,014	60,907	2,886	421,637

Statement VI—Karnataka

1960	420	..	420	72	100,557
1961	545	10	555	58	17,248
1962	2,379	..	2,379	35	43,904
1963	647	..	647	40	36,514
1964	1,040	..	1,040	17	104,218
1965	778	..	778	7	68,476
1966	1,696	..	1,696	52	65,630
1967	1,260	..	1,260	18	49,185
1968	5,425	1	5,426	16	87,822
1969	3,980	..	3,980	26	75,793
1970	7,538	1	7,539	34	116,936
1971	4,420	..	4,420	1,763	103,724
1972	8,058	17	8,075	346	92,676
1973	8,235	1	8,236	934	19,484
1974	12,695	1	12,696	860	76,033

APPENDIX 39.4—*Contd.*

Statement VII—Goa

(tonnes)

Year	Penaeid prawns	Non-Penaeid prawns	Total prawns	Other crustacean	Total marine catch
1960 . . .	..	..	..	1	1,439
1961 . . .	..	..	..	4	452
1962 . . .	N.A.	N.A.	N.A.	N.A.	N.A.
1963 . . .	N.A.	N.A.	N.A.	N.A.	N.A.
1964 . . .	N.A.	N.A.	N.A.	N.A.	N.A.
1965 . . .	956	..	956	27	17,186
1966 . . .	1,328	..	1,328	12	24,600
1967 . . .	610	..	610	8	12,460
1968 . . .	759	..	759	..	18,888
1969 . . .	559	..	559	5	27,559
1970 . . .	627	..	627	5	20,736
1971 . . .	279	..	279	11	39,980
1972 . . .	561	..	561	7	30,104
1973 . . .	785	..	785	20	15,740
1974 . . .	795	..	795	41	18,056

Statement VIII—Maharashtra

Year	Penaeid prawns	Non-Penaeid prawns	Total prawns	Other crustacean	Total marine catch
1960 . . .	9,278	34,605	43,883	48	127,172
1961 . . .	8,166	21,744	29,910	46	111,839
1962 . . .	8,077	33,725	41,802	2	123,702
1963 . . .	5,032	37,482	42,514	14	121,357
1964 . . .	14,301	29,324	43,625	18	130,603
1965 . . .	9,796	40,412	50,208	58	131,907
1966 . . .	9,864	33,312	43,176	135	134,339
1967 . . .	8,136	28,376	36,512	35	133,302
1968 . . .	11,296	30,311	41,607	14	123;916
1969 . . .	14,545	31,235	45,780	144	168,720
1970 . . .	28,920	28,425	57,345	5,625	192,361
1971 . . .	18,974	74,637	93,611	979	215,305
1972 . . .	20,173	83,952	104,125	487	220,002
1973 . . .	16,894	63,455	80,349	687	226,696
1974 . . .	14,712	50,025	64,737	973	184,961

N.A.—Not available.

APPENDIX 39.4—*Contd.*

Statement IX—Gujarat

(tonnes)

Year	Penaeid prawns	Non-Penaeid prawns.	Total prawns	Other crustacean	Total marine catch
1960 . . .	4,917	365	5,282	25	127,982
1961 . . .	2,012	190	2,202	13	19,396
1962 . . .	1,497	848	2,345	4	97,751
1963 . . .	1,697	1,966	3,663	6	101,881
1964 . . .	1,330	832	2,162	..	92,882
1965 . . .	3,948	507	4,455	..	80,590
1966 . . .	4,094	448	4,542	74	80,339
1967 . . .	3,653	416	4,069	14	75,633
1968 . . .	3,221	499	3,720	1	86,585
1969 . . .	2,622	651	3,273	1	82,248
1970 . . .	2,653	946	3,599	..	89,027
1971 . . .	2,873	141	3,014	3	82,159
1972 . . .	2,013	218	2,231	393	75,846
1973 . . .	10,550	70	10,620	749	121,963
1974 . . .	3,420	149	3,569	211	109,091

Statement X—Lakshadweep

1960 . . .	..	..	..	..	509
1961 . . .	..	..	..	..	872
1962 . . .	..	..	..	..	178
1963 . . .	..	..	..	..	589
1964 . . .	..	..	..	..	79
1965 . . .	..	..	..	..	471
1966 . . .	..	..	..	..	660
1967 . . .	..	..	..	..	883
1968 . . .	..	..	..	..	1,120
1969 . . .	..	..	..	..	1,193
1970 . . .	..	..	..	..	1,165
1971 . . .	..	..	..	..	1,190
1972 . . .	..	..	..	..	1,080
1973 . . .	..	..	..	..	1853
1974 . . .	..	..	..	..	2,232

APPENDIX 39.4—(*Concld.*)

Statement XI—Andamans

(tonnes)

Year	Penaeid prawns	Non-penaeid prawns	Total prawns	Other crustacean	Total marine catch
1960 . .		..	..	..	129
1961 . .	..	..	..	..	131
1962 . .	1	..	1	..	155
1963 . .	2	..	2	..	159
1964 . .	2	..	2	..	148
1965 . .	4	..	4	..	224
1966 . .	5	..	5	..	330
1967 . .	12	..	12	..	410
1968 . .	6	..	6	..	341
1969 . .	8	..	8	..	412
1970 . .	10	..	10	..	500
1971 . .	12	..	12	..	569
1972 . .	12	..	12	..	780
1973 . .	8	..	8	..	854
1974 . .	28	..	28	..	920

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APPENDIX 39·5

(Paragraph 39.6.1)

Exp:rt of Crustacean Products from India

Statement I— Quantity

(tonnes)

Year	Prawns								Lobster tails		Crab meat		Squ-lla tails	Total	Percen-tage of total export
	Frozen	Canned	Dried	Pick-led	Curr-ied	Meal	Powd-ered	Bits	Fro-zen	Cann-ed	Fro-zen	Cann-ed			
1960 . .	1,939	320	2,732	..	..	..	..	..	..	..	..	..	..	4,991	30·0
1961 . .	2,562	622	3,602	..	..	..	..	..	..	..	..	..	..	6,786	27·7
1962 . .	2,238	970	3,068	*	..	..	47	..	40	..	*	..	..	6,363	54·8
1963 . .	3,967	1,231	2,809	..	..	..	255	..	53	..	..	..	..	8,315	46·4
1964 . .	5,870	1,074	3,009	*	*	..	511	..	41	..	..	..	..	10,505	48·9
1965 . .	7,028	1,148	1,702	*	..	2	104	..	112	..	*	..	..	10,096	65·3
1966 . .	8,784	1,523	1,163	2	..	..	82	3	81	..	1	..	..	11,639	60·8
1967 . .	11,173	2,200	1,540	4	..	6	123	5	128	..	*	..	..	15,179	69·7
1968 . .	14,397	2,238	1,411	8	..	..	5	3	297	..	..	..	*	18,359	74·0
1969 . .	21,441	1,661	835	3	*	..	1	2	529	*	..	..	*	24,472	80·0
1970 . .	22,135	2,578	1,486	7	..	..	23	17	382	2	..	..	..	26,630	71·6
1971 . .	23,181	1,864	684	6	..	..	5	46	326	*	..	..	..	26,112	76·7
1972 . .	30,550	1,058	139	6	..	..	8	..	369	..	..	7	..	32,137	83·9
1973 . .	35,895	2,199	284	3	..	..	9	*	380	1	..	19	..	38,790	79·5
1974 . .	34,361	1,516	116	*	..	..	5	..	456	..	..	14	10	36,478	78·2

* less than one tonne.

APPENDIX 39·5—(*concld.*)

Statement II—Value

(Rs. thousands)

Year	Prawns								Lobster tails		Crab meat				
	Frozen	Canned	Dried	Pickled	Curried	Meal	Powdered	Bits	Frozen	Canned	Frozen	Canned	Squilla tails	Total	Percentage of total export
1960 .	14,804	1,784	@	..	..	..	..	..	..	..	..	..	..	16,588	41·2
1961 .	20,075	4,223	@	..	..	..	..	..	..	..	..	..	..	24,298	58·8
1962 .	10,820	6,559	8,944	*	..	..	22	..	226	..	*	..	..	26,571	70·9
1963 .	21,204	7,576	9,325	..	..	..	84	..	313	..	..	..	..	38,502	65·7
1964 .	31,518	6,989	8,997	3	*	..	126	..	371	..	..	..	..	48,004	70·1
1965 .	41,422	9,506	5,447	3	..	..	67	..	1,274	..	5	..	..	57,724	83·4
1966 .	88,792	18,657	5,271	13	..	..	56	6	1,474	..	8	..	..	1,14,277	84·5
1967 .	1,29,808	31,243	8,961	30	..	6	99	21	2,357	..	3	..	..	1,72,528	86·6
1968 .	1,56,340	26,156	7,259	64	..	..	21	1	6,684	..	..	..	10	1,96,535	89·0
1969 .	2,62,945	22,104	4,840	19	*	..	5	2	11,224	11	..	..	6	3,01,156	91·1
1970 .	2,42,515	39,541	8,361	45	..	..	40	37	6,021	128	..	..	..	2,96,688	83·5
1971 .	3,13,363	29,757	3;742	40	..	..	29	57	10,942	37	..	..	..	3,57,967	91·4
1972 .	5,08,843	21,026	1,380	45	..	..	111	..	12,794	..	..	109	..	5,44,308	93·6
1973 .	6,58,122	52,369	3,230	20	..	..	59	4	10,663	28	..	384	..	7,24,879	91·1
1974 .	6,37,326	47,842	1,426	12	..	..	40	..	12,573	..	..	510	13	6,99,742	91·7

@ Included in frozen.

* less than Rs. thousand.

APPENDIX 39.6

(Paragraph 39.6.2)

Utilisation of Crustacean Landings

Crustaceans	Utilisation
I. fresh prawns	(a) sold in production centres without icing. (b) sold in internal markets by placing in ice.
II. processed prawns	
1. dried prawns	(a) sold in production centres and internal markets. (b) exported.
2. prawn pulp	(a) sold in production centres and internal markets. (b) exported.
3. frozen prawns	(a) sold in internal markets. (b) exported.
4. canned prawns	(a) sold in internal markets. (b) exported.
5. pickled prawns	(a) sold in internal markets. (b) exported.
6. powdered prawns	exported.
7. curried prawns	exported.
8. prawn meal	exported.
9. prawn bits	exported.
III. lobster tails	
1. fresh	sold in internal markets.
2. frozen	exported.
IV. crab	
1. fresh	sold in internal markets.
2. processed meat	exported.

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40

MARKETING OF FISH AND FISHERY PRODUCTS

1 FISH MARKETING WITHIN INDIA

40.1.1 Important aspects of marketing concerning the complex of all agricultural commodities have been dealt with in Chapter 56 Marketing, Transport and Storage. Only specific aspects pertaining to the problems of fish marketing within the country are given in this section. These problems are basically related to the combination of certain factors viz. (a) production characteristics influencing supplies; (b) demand and consumption patterns determined by geography, tradition and nutritional standards; (c) trading practices; and (d) the perishable nature of the produce, necessitating proper treatment soon after catching.

Production Characteristics

40.1.2 Marine fisheries : To have a comparative idea of marketing activity primarily at the production level, the annual catches of 1973 in different maritime States have been given in Appendix 40.1. There are about 1,800 fishing villages scattered all along the coastline, indicating a great dispersion in marine fish landings which constitutes an initial handicap in concentrating the catches at a few assembly centres for organising large scale marketing of marine fish for inland areas.

40.1.3 Fish production is composed of numerous species of

40.1.3 Fish production is composed of numerous species of landed annually due to fluctuations occurring in individual fisheries in the sea itself. Secondary factors are also at work inducing variations in demand and consumption patterns because of availability, prejudices and preferences. This is always reflected in the price structure not only of different species but also of the same species, during different seasons and from year to year as also in types of processing requirements. Marketing of different varieties of fishes and shellfishes, which are generally considered as a single commodity as fish, is in practice a matter of great complexity.

40.1.4 The marketing of fish, which are of prime quality or of established acceptability, does not pose problems because the movement of the catch from the landing sites at reasonable price to the producers gets stabilised by the trade. The marketing of species, which are caught in large quantities having wide variations in their annual landings, or which are caught in appreciable quantities but have no acceptability in the markets for obtaining reasonable returns to the producers present serious problems in marketing. The latter are called "lesser fish" and "trash fish".

40.1.5 In the above categories the marketing of oil sardine and mackerel needs special consideration. These two types constitute about 30 per cent or 0.35 million tonnes of the total marine fish catch of India. In the two major fish producing states of Kerala and Karnataka, they contribute nearly 60 per cent and 70 per cent of their respective catches. Developments have no doubt taken place in providing greater ice production and cold storage capacity in these two States during the successive plans thereby increasing the marketability of these fishes in fresh (iced) condition and in extending the area of marketing to inland regions not far away from the landing sites. But despite the facilities developed, it is a common experience that large quantities are still being disposed of at very low price for extraction of oil and reduction to fishmeal. It is unfortunate that adequate attempts have not been made in expanding the markets for these fishes in distant places, particularly keeping in view that their catches are likely to be further increased by exploiting the extended resources recently discovered. Likewise, other sardines, caught in fairly large quantities, particularly on the eastern coast along Tamil Nadu and Andhra Pradesh hold a potential for market expansion, which would serve as an incentive to marine fishermen in their price structure for increasing production. Thus increased marketing of mackerel, all sardines and other pelagic fishes, by virtue of their quantities, would constitute an important step in the development of the marketing of marine fish in inland areas. We, therefore, feel that there is an urgent need for undertaking marketing development in all the inland areas which have potential for absorbing increased supplies of all marine fish, particularly those which are being landed in large quantities in the coastal areas.

40.1.6 With the increase of trawl catches in the total marine fish production, there has been proportionate increase in the landings of "lesser" varieties of fish. Fishing by different methods in offshore waters would also add considerably to their quantities in future. Nutritionally as important as the prime fishes, the lesser varieties are considered inferior in quality mostly in the coastal areas and near inland markets mainly because good table fish are easily obtained. As such, these varieties of fish find either no market or fetch very low price at most of the landing centres. It is on this account that possibilities are being examined by Central Institute of Fisheries Technology (CIFT) for utilising them for conversion into silage or animal feed. But it is encouraging to know that such varieties are being gradually accepted as human food fetching comparatively reasonable prices in larger consuming coastal centres like Bombay. We recommend that steps should be taken for popularising the lesser varieties of fish amongst the larger sections of the consuming public, particularly through extension services with pilot catering, films and other requisite means of mass communication. Such a step towards improved marketability of these fishes would also bring better returns, which is significant for the economic viability of offshore fishing for increasing marine fish production.

40.1.7 The marketing of marine fish has important seasonal aspects in relation to production. Analysing the data for the ten years, 1963-72, on the basis of quarterwise landings, it is seen in Appendix 40.2 that the production in the States bordering on the west coast during the second and third quarters, gets considerably affected because of reduced fishing effort owing to the south-west monsoon conditions; the production in Karnataka reaches quite low ranging between 6.20 and 6.72 per cent of the annual landings in both the quarters and in Maharashtra it goes down to 6.90 per cent and in Gujarat to 4.86 per cent in the third quarter. The production on the east coast is, however, more evenly spread out during the four quarters. The fresh fish markets are, therefore, starved of the supplies from the west coast. Daily supplies of fresh (iced) fish to the retail markets, even during the quarter when production is highest show considerable fluctuations in line with the catches landed. During the days of plentiful catches, the producers are generally at a disadvantage in getting fair price and the retailers taking larger quantities for marketing are many a time left with undisposed and decomposed fish at the end of the marketing time. These marked seasonal and daily changes in supplies therefore raise the problem of evening out supplies for marketing which has been discussed later in this section.

40.1.8 The fish landing sites constitute the primary stage of marketing marine fish. The producers offer their marketable surplus for sale, not by weight system, but by measures of heaps, lots or baskets; such unit measures vary not only from locality to locality but also within the same locality and for the same types of fish, depending upon the size of the catch. In other countries also, the disposal of marine fish at the fishing-port markets or at the landing sites, by weight system has not been found practicable, because of the great rapidity with which this perishable commodity has to be transacted; but in most of the countries, the containers as units of measures have been of standard sizes to facilitate the collection of data on market intelligence and for marketing the commodity itself. It is, therefore, suggested that State fisheries organisations should examine the introduction of standard measures for different types and sizes of marine fishes at the primary marketing stage. This would enable the collection of necessary data for market-intelligence the lack of which has been a serious handicap in evaluating production costs.

40.1.9 The provision of marketing-sheds at the fish landing sites, where catches are being landed on the open beaches or open grounds, is a basic necessity. No data are available on the number of sites where such facilities are already provided, but it can safely be stated that such a facility does not exist at a large number of landing sites along the coast. The principle of concentration of fish landings will primarily be an economical approach to provide as fewer numbers of marketing-sheds as possible, in view of the large number of landing centres scatered all along the coastline of the country. The introduction of large numbers of mechanised boats has led to the concentration of fish landing at specific points; the proposed construction of fishery harbours, would include the provision of marketing-sheds or auction halls besides other ancillary facilities such as ice factories, cold storages etc. around the harbour areas. However, it would not be practicable to cover all the dispersed fish landing sites under the harbours that would be provided in the next 25 years. Besides, most of the fishermen who are operating non-mechanised boats would not like to land their catch at the minor or major fishing harbours because of competition in marketing. It is also the tendency of the marine fishermen to land their catches near their fishing villages. We, therefore, recommend that marketing-sheds should be provided at suitable fish landing centres. The construction of marketing sheds might have to be a phased programme in the order of the quantities of fish landed so as to create an opportunity for the concentration of fish-landing at least from the adjoining centres.

40.1.10 Another essential facility would be the provision of feeder roads, linking those fish landing sites which have considerable marketable surplus with the nearest railway stations or motorable roads for onward transportation by rail or by motor trucks as a quick means of transport necessary for marketing fresh fish in good quality to the terminal markets.

40.1.11 Inland fisheries : Unlike marine fish which come only from capture fisheries, the inland fish production is contributed both by capture and culture fisheries from the freshwater resources in all the states, and additionally from brackish waters in the maritime states. The estimates of inland fish production for 1973 and the comparative intensity of marketing requirements at the production level for all States have been given in the Appendix 40.1. The marketing problems, which arise out of considerable variations characterising marine fish production creating glut and lean periods are not of any significant dimensions in the case of production from the inland fisheries. Besides, the inland fish production, in general, is characterised by fewer species which have established acceptability and are marketed in fresh condition mostly by weight system. The marketing of catch from culture fisheries resources, netted out periodically during the whole year from perennial waters and during 2-3 months prior to monsoon from long seasonal tanks, would not cause problems, as the netted catch can be held in a live condition in net enclosures for making phased supplies to the nearby markets. The problem would, however, arise in case of capture fisheries of riverine, estuaries and reservoirs, because of scattered landings at several places. It would, therefore, be necessary to identify the potential centres where such landing could be concentrated so that marketing conditions could be improved by providing marketing sheds, preservation and transport facilities.

Availability, Consumption and Demand

40.1.12 Appendix 40.1 gives annual per capita availability of fish, separately for marine, inland and total, in different States, based on respective population in 1971 and fish production in 1973. The percentage of fish and meat eating population varies in States between about 35 in Gujarat and 95 in Assam and West Bengal, with all-India average of about 70. Per capita availability adjusted to the percentage of meat-eating population in the States for which the relevant information is available, has been given in the column 9. According to the Indian Council of Medical Research, balanced diet for meat-eating adult should include 30 gm of fish and meat per day. Of this, it might be assumed that 20 gm would come from fish. On this basis, the per adult requirement of whole fish, after allowing for 40 percent cleaning losses, works out to 12.2 kg/annum. The per capita requirements of whole fish would work out to about 10 kg/annum. As can be seen from the Appendix, only Lakshadweep, Goa, Daman and Diu, Pondicherry, Kerala and Gujarat have the requisite per capita availability. As regards other States, except Maharashtra and Tamil Nadu where availability is only marginally lower, per capita availability falls much below the desired level.

40.1.13 Per capita consumption of fish varies from State to State and within each State from region to region. In general fish constitutes an important item of food in the diet of the people living in the coastal regions and in the Eastern States of the country comprising West Bengal, Orissa, Assam, parts of Bihar and the Union Territories of North Eastern India. In other parts of the country, fish is only a supplemental item of food.

40.1.14 The bulk of the marine catch is at present marketed within the coastal districts, except in the Gujarat State which markets its major production outside the State, the marjority of its population being vegetarian. Considering the fish production in relation to population in the coastal districts only, it can be stated that the per capita availability in these districts would be much more than what has been estimated on the basis of population in the State as a whole. The problem of meeting the demand with increased supplies would, therefore, pertain to the eastern States where fish is an important item of food. Inland fish, particularly major carps are already being sent by other States to the eastern sector because of highly favourable price. For the same reason, bulk of the fish catch from Chilka lake is also being marketed in Calcutta despite the great demand of fish in Orissa itself. Considerable quantities are still needed to feed the Calcutta markets. To have an idea of the demand approximately on the basis of meeting at least the consumption level as per the nutritional requirement, if not as an important item of diet, the State of West Bengal alone, as an example representing the eastern sector, would require 4.9 lakh tonnes as against the production of 2.4 lakh tonnes in 1973. This gives an indication of the wide gap between production and the requirements in the eastern sector. This gap has to be narrowed down by increasing production within these States and also by increasing supplies and developing distribution system of fish both marine and inland from other States.

40.1.15 As supplemental item of diet, the consumption of fish as has been steadily increasing and the supplies have been reported to be considerably inadequate to meet the growing demand particularly in the urban areas. With 70 million people living in towns each having population of over 50,000, it is estimated that about 0.55 million tonnes at the rate of 11 kg per person per annum are required to be supplied. It can thus be seen from the consumption patterns that the marketing of fish by way of making adequate supplies would assume greater importance in the regions where fish constitutes a significant as well as a supplemental item of food.

40.1.16 Appendix 40.3 gives the supply and demand position of fish in 1971, and the projections for 1985 and 2000 AD. It can be seen therefrom that, on the basis of nutritional requirements in which fish forms one of the main components of animal protein in diet, computed at 11 kg per annum per head, the requirement in 1971 should have been of the order of 4.21 million tonnes. However, the availability for domestic consumption in 1971 was only of the order of 1.61 million tonnes, giving per capita per annum availability of 4.2 kg. The projected production in the years 1985 and 2000 AD both from inland and marine fisheries together would come to about 4.28 and 8.00 million tonnes respectively. However, the balance as fish food for domestic consumption, after deduction of quantities for export and for the manufacture of fishmeal and other industrial products, would be of the order of 3.78 and 6.75 million tonnes respectively, raising the per capita availability to 7.4 and 10.3 kg per annum respectively. This indicates that we shall be able to meet by and large the minimum nutritional requirement of fish by 2000 AD. These projected supplies would correspondingly necessitate planning for marketing developments, including processing, transport and distribution facilities, which would be of the order of about twice the present activity in 1985 and four times by 2000 AD.

Trading Practices

40.1.17 Primary trade involving disposal of fresh fish landed by the fishermen is a marketing activity of daily turnover. There is a small amount of trade comprising direct sales by the producers to the consumers or to the retailers mostly confined to the markets situated in close proximity of the production centres. The bulk of the fish trade, however, involves intervention of some middlement agency as most of the fishermen have neither adequate time to take care of marketing their catch nor do they have the business acumen and knowledge of marketing conditions. Private agencies of middlemen exist all over the country despite their malpractices in the trade. It is natural to expect that longer the chain of intermediaries or functionaries between the producers and the consumers the higher will be the cost of incidentals component and proportionately less will be the share of producers in the consumer price. Such long chains in fresh fish trade are mostly prevalent in the eastern sector. An example, as tenable in Calcutta fish markets, is given below:

primary producer→ collecting agents on commission→ wholesalers or *aratdars*→ guarantors or *chattadars* for recovery of payments from lot retailers (working on commission)→

first →auction→ lot retailers→ second auction→ retailers→consumers→

Besides the problem of too many intermediaries in which producers and consumers are at a disadvantage, it has also been reported that the fish trade in some of the big cities such as Calcutta is controlled by a few wholesalers with vested interests. It is, therefore, recommended that the State fisheries organisations and marketing authorities should examine the question of elimination of unnecessary links in the prevalent trading practices and introduce the system of licensed functionaries in fish marketing to the best advantage of the producers and consumers.

40.1.18 To overcome the disadvantages of private agencies, and to give the fishermen producers a greater degree of control over the marketing of their own produce, the fishermen co-operatives will have to increasingly develop their marketing functions. There are only a few co-operatives in the country, mainly district federations, which undertake marketing functions of varying types. This activity has, no doubt, exerted some salutary effect on the malpractices of the private agencies, but it has not yet created the desired impact. In developing marketing services, the co-operatives have to face very strong competition of the private agencies which, because of their long experience, have acquired expertise in marketing functions and have the adequate financial resources at their disposal. In these circumstances, if the co-operatives have to assume an increasing role in developing marketing functions, they will have to raise their standard of efficiency in marketing methods, get the unstinted loyalty of the members in making marketing an obligatory function in the by-laws of the co-operatives. They will also have to be provided with necessary credit for working capital from governmental resources and financial institutions.

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Processing, Transport and Distribution

40.1.19 Utilisation pattern: Almost the entire catch of inland fish is marketed in fresh condition, with or without ice. The marine catch is processed into different forms such as fresh fish, canned, frozen and cured products for human consumption, and for manufacturing fish meal, oils, manure and other industrial products. The changing pattern in utilisation of marine catch since 1951, considering its disposition every five years, is given in Appendix 40.4. It is seen therefrom, that the combined percentage of sun-dried and salt-cured products has decreased from about 70 to 30, whereas the percentage of fresh fish consumption has increased from 20 to 50. This change in the utilisation pattern is attributed to the progressive increase in the capacity of ice production and cold storage facilities to the extent of 14 and 11 times respectively during the period between the First Plan and the end of the Fourth Plan. However, in terms of absolute quantities, the processing of sun-dried products has not shown any reduction, whereas in the case of salt-cured products there has been a downward trend. As regards the diversion of marine fish for reduction into fish meal, although the quantities have increased in relation to total production of marine fish, the percentage has remained more or less constant. In the later years, the processing sector for frozen and canned products progressively developed to cater mainly for export market. It is thus seen that fresh fish, sun-dried and salt-cured products constitute the main components in the fish processing and preservation industry for domestic consumption.

40.1.20 Quality control and inspection: Fish is one of the most perishable of all foods. The spoilage starts right from the time it is brought out of water. Under Indian conditions, untreated fish becomes unwholesome within about eight hours. This would, therefore, mean an initial responsibility on the part of fishermen to preserve the quality for primary marketing either by returning with the catch in reasonable time or in case of longer time by adopting necessary measures such as chilling fish on board the fishing boats or in keeping the catch duly covered to avoid direct exposure to the sun, and by observing necessary sanitary conditions. Further responsibility in maintaining the quality of fresh fish in ice upto the retail marketing, including packing, transporting and sanitation in the retail markets, lies with the trade. The quality of fish that is being marketed at present requires considerable improvement. As regards quality of cured products, it is known that curing has often served merely as an outlet for utilisation of unwholesome fish. The cured products would continue to play an important role in the diet specially for the poorer sections of the community all over the country, as these are comparatively cheaper in price and are easily transportable. As such, the raw material used for curing industry should also comprise wholesome fish. Besides, improvements in curing methods to give quality products are also necessary.

40.1.21 Under the Division of Agriculture and Food Products of the Indian Standards Institution, the committees on fresh, frozen, canned and dried fish products have brought out national standard specifications for different products (Appendix 40.5) on the basis of of draft specifications mainly developed by the CIFT. These standards are being followed mainly for export products through the system of pre-shipment inspection which is being carried out by the Export Inspection Agency under the Export Inspection Council of the Ministry of Commerce. However, the observance of these standards has been voluntary with reference to domestic consumption of fish and fishery products, mainly because of lack of satisfactory surveillance in the system of quality control and inspection. Alongwith other perishable foods, the quality inspection of fish and fishery products is being administered through the health service. In the context of improving this service with reference to animal health and products, suitable recommendations have been made in Chapter 35 on Animal Health for reinforcement of this service with personnel qualified in veterinary public health. By imparting short-term training in quality control and inspection of fish and fishery products to the personnel of different public health services, necessary improvements in the field of fish inspection could also be brought about. We, therefore, recommend that short-term training courses in quality control and inspection of fish and fishery products be organised at a suitable central fisheries institute and that requisite national standards for analytical methods in quality control and inspection be formulated jointly by ISI, Central and State fisheries organisations.

40.1.22 Preservation, transport and distribution of fresh fish in ice is an intense marketing activity. However, by and large, the consumers correlate iced fish with stale fish and accordingly the fish retailers cater to the wrongful practice of selling fish without keeping in ice. Besides they are also under the impression that gutting and decapitating fish is generally undertaken to mask the staleness in fish. This has, therefore, hampered even the introduction of fish filleting in the industry which would incidentally give sizeable quantities of fish offal for conversion into fish meal. Consumers have, therefore, to be educated to know that preservation of fish in ice is a necessary step to maintain the nutritive value of fish and that bacterial and autolytic decomposition is checked by gutting and decapitating. We, therefore, recommend that the Central and the State fisheries organisations should undertake necessary steps for educating the consuming public through the mass media of communications so as to make them conscious that icing of fish and gutting and decapitating of fish in filleting sector of the industry are necessary steps in maintaining the freshness and nutritive value of fish.

40.1.23 Fish icing: Preservation of fish in ice being the most intense activity in the internal system of marketing, proper icing procedures would require considerable care so as to avoid wastage of ice and fish, and at the same time make the whole system as economical as possible. These procedures would primarily entail, using adequate quantities of ice to last for expected duration and distances to which the consignments are to be sent, proper stratification of ice and fish in containers to see that desired chilling takes place all over and that fish are not unduly pressed, correlating requirement of ice in relation to temperature with a view to economising on use of ice in winter, and finding out suitable containers for packing purposes of fish with economical insulating materials against heat entering from outside. In this context it may be stated that some research work has already been conducted at the CIFT and useful results have been obtained, but no specifications have so far been formulated for adoption by the trade. There is also a need to intensify research on the aforementioned aspects. The CIFT should formulate the specifications on the methods of packing fish and ice in suitable containers with economical insulation materials as early as possible so that these could be adopted by the trade. Research on proper procedures of chilling different types of fish for marketing in the country should be intensified.

40.1.24 Sun-dried Products: There is a need to improve, the quality of sun-dried products such as Bombay duck, ribbon fish etc. by adopting a better dehydrating method to reduce the moisture content. The present traditional methods, bring about considerable wastage in storage due to infestation by insects and fungal growth, and spoilage due to bacteria. The CIFT, in experimental trials, obtained a better quality product, by dehydration in a mechanically worked tunnel air dryer designed by the Institute. However, this improved method has not been adopted anywhere in the areas where sun-drying is being predominantly undertaken. This is probably due to the absence of demonstrations of economic advantages of these methods over the existing methods. We are, therefore, of the view that CIFT should undertake pilot projects in co-ordination with State fisheries organisations to demonstrate the economic advantages of mechanical air-dryers over the existing traditional methods in some of the suitable areas where sun-drying of fish is being predominantly undertaken.

40.1.25 Fish freezing: In developed countries consumption of perishable commodities, including fish and shellfish, gets evened out by marketing different varieties of processed products such as frozen, canned, salted, smoked, ready to cook items in convenient packs etc. In this, special consideration is given to the preservation of fish and shellfish by developing increased capacities both shore-based as well as on factory ships with freezing facilities on board, so as to increase shelf life. This is necessary not merely to even out supplies of frozen fish but also to phase out the supplies of raw materials to the processing factories. In India, except the availability all the year round of sun dried, salt-cured and to some extent canned products, the availability of fresh marine fish is greatly uneven. The development of the processed products other than frozen fish on large scale, as is being done in the developed countries, will have to be in line with the general development of the food industry of all perishable commodities. But there is need for giving special consideration to the development of fish freezing industry in our country with a view to increasing the shelf life of marine fish so as to even out supplies during the season of high production and extending the marketability to other seasons and in the distant areas.

40.1.26 The marketing of frozen fish generally involves a chain of freezing complex right from production centres upto the retailing points, including refrigerated methods of transport. In planning the development of this system for domestic consumption of fish, it may be advisable to undertake a phased programme so as to be economically in tune with the growth in demand for frozen fish. This would, therefore, direct the initial need of establishing large scale freezing plants and storages near production centres where from bulk quantities of fish could be absorbed at comparatively cheaper price to relieve gluts. This would not only give an economic advantage to the producers, but it would also enable making increased supplies of fish in seasons of shortage at reasonable price to the consumers even at distant places, particularly in the sectors of the country where fish constitutes an important item of food. The experimental trials conducted by CIFT have shown that frozen sardines, packed in insulated boxes despatched from Cochin to Calcutta by ordinary parcel van of a passenger train, reached in good condition. The fish were marketed after thawing as fresh fish (=iced fish), thereby indicating necessary commercial possibilities for adopting this system in the initial stages. The total cost, excluding fish but including all other charges, such as freezing, transport, packaging materials, charges for return of insulaing materials for reuse and other incidentals, came to about Re. 1 per kg of fish, in 1972. The cheaper varieties of fish such as sardines, mackerel etc. are generally priced at the production centres within the range of Rs. 250-500 per tonne during the time of seasonal abundance. By assuming the price as high as Rs. 1,000 per tonne, the cost of such frozen fish at the consumption centres would be about Rs. 2 per kg. This gives an indication of the prospects of not only a considerable profit margin but also making fish available to the consumers at reasonable prices say Rs. 3 to 4 per kg as against the price of Rs. 8 to 12 per kg for convential varieties prevailing in the Calcutta markets.

40.1.27 With the objective of making fish available at reasonable rates in Calcutta and its suburbs, the Central Fisheries Corporation, jointly sponsored by the Central and some of the State Governments, has been undertaking marketing activity, since its establishment in 1965, by procuring supplies and retailing fish by organising a chain of fish stalls. It has been reported that the Corporation has undergone an accumulated loss of about Rs. 1.0 crore. This has been attributed to handling inadequate quantities of fish because of the difficulties in procuring supplies from the States. Although the Corporation has improved its balance sheet to some extent, it has not been able to achieve the primary objective of making fish available to large number of consumers at reasonable prices. The prospect of realising the objective seems to be possible through procuring larger quantities of marine fish from the States, for which the Corporation will have to establish necessary freezing facilities, initially near the production centres in co-ordination with State fisheries corporations wherever they are organised or other State fisheries organisations. The Corporation would then be able to create an impact on price structure not only in Calcutta but in the entire eastern sector followed by extending its marketing activity to other cities in the entire country. It is, therefore, recommended that the Central Fisheries Corporation and State fisheries corporations/organisations should establish in a co-ordinated manner freezing plants and storages near important production centres for getting adequate supplies of fish for expansion of its marketing activity. This development could then be extended to create further facilities at various consumption centres.

40.1.28 Transport and distribution: The main problem, which needs consideration in expanding the activity of marketing, would pertain to quick and efficient transport, involving short and long journeys, for carriage of large quantities of iced and frozen fish. For short distances of upto about 200 km, developments have taken place in providing motor trucks between some of the production and supply centres connected by road, and the fisheries co-operatives are being financially assisted by way of loan and subsidies for procurement of trucks. Wherever this transportation service could be extended economically, the State fisheries organisations should promote this scheme by giving necessary financial assistance.

40.1.29 For improving long distance transport, the Government introduced six refrigerated rail vans in 1961, fabricated indigenously by the Ministry of Railways with equipment supplied by Technical Co-operation Mission of USA. Subsequently six more such vans have been introduced, which were indigenously fabricated with some imported components. In 1965, 26 refrigerated road vans were imported from Hungary and distributed amongst various States for the transport of fish by road.

40.1.30 It has been reported that the use of refrigerated road vans in most of the cases has been extremely disappointing. Many of the State fisheries organisations have either transferred these vans to other departments or they are not being put to adequate use. As regards refrigerated rail vans, the performance has not been any better. The Ministry of Railways, it has been reported, has sustained a loss of about Rs. 64.00 lakhs on operating these refrigerated rail vans. The inadequate utilisation has been attributed to absence of daily service, unsuitable train timings, limited loading facilities enroute, and the practice of returning the vans empty on return journey. Viewing this situation against the quantities that would be transported in future, it may not be advisable to undertake developments in further increasing this facility in the immediate future for domestic consumption of fish. Bulk of fresh fish is still being transported in ordinary brake vans, in which if proper icing procedures are followed, the produce reaches in a desirable condition at distant places. However, in achieving efficiency in the transport of iced and frozen fish to be thawed and marketed as fresh fish, there would be a need of an intermediate stage of introducing progressively well insulated rail and road vans. This seems to be a logical step, as these vans as the need arises in future, could be refrigerated even for the transport of frozen products. We, therefore, recommend that for improving the transport system for carriage of iced and frozen fish, the question of introducing insulated rail and road vans on large scale to meet the expanding marketing activity should be examined, as an intermediate stage in the development of refrigerated transport system.

2 EXPORT OF MARINE PRODUCTS

India's Share in World Trade

40.2.1 India's percentage contribution to the world export of fish and fishery products, during the period 1970-73, ranged between 0.5 to 0.7 per cent in terms of quantity and 1.4 to 2.0 in terms of value. This indicates that India's share being negligible, there is a considerable scope to expand the export trade of Indian fish and fishery products by undertaking necessary promotional measures by MPEDA.

Promotional Agency

40.2.2 The foreign exchange earnings from the export of fish and fishery products increased from Rs. 2.46 crores in 1951 to Rs. 6.23 crores in 1959. Initial move for augmenting marine product exports was taken by the Ministry of Food and Agriculture, Government of India, in 1957-58 when several incentive schemes were started. Realising the further potentialities of foreign exchange earnings from this trade, the Government of India set up the Marine Products Export Promotion Council in the Ministry of Commerce in 1961. The Council was reconstituted in 1972 as the Marine Products Export Development Authority (MPEDA), with considerable executive powers and autonomy in operation, as per Act 13 of 1972. As per the Act, Marine Products include all aquatic products from fresh, brackish and sea waters and it is in this sense that this term has been used in this

Section. The provisions of sub-sections (1) and (2)(a) under Section 9 of the Act which read as follows need consideration :

> "9(1) It shall be the duty of the Authority to promote, by such measures as it thinks fit, the development under the control of the Central Government of the marine products industry with special reference to exports.
>
> (2) Without prejudice to the generality of the provisions of sub-section (1) the measures referred to therein may provide for—
>
> (a) developing and regulating off-shore and deep-sea fishing and undertaking measures for the conservation and management of off-shore and deep-sea fisheries."

Initially, it may be stated that the Act does not define the terms "off-shore" and "deep-sea" fisheries. Assumption by the Authority of the functions implied in sub-section (2a), involving the aspects of both research and development with reference to off-shore and deep-sea fisheries, would lead to the creation of an anomaly in view of the fact that these functions also fall within the purview of the Ministry of Agriculture and Irrigation and State Fisheries Organisations, which have the necessary technical expertise and facilities. Besides, considering different types of products in the international trade, it is felt that the coastal fisheries of India offer greater scope for diversified products for increasing export than the products which could be obtained from the exploitation of off-shore and deep-sea fishing which has an orientation more towards domestic consumption except, of course, tuna fishing. We, therefore, recommend that the anomaly regarding the assumption of the functions by the MPEDA with reference to development, conservation and management of off-shore and deep-sea fisheries as laid down in the Act should be removed by the Government in the interest of this Authority directing its well-concerted efforts towards the promotion of export of marine products.

Trends in Exports

40.2.3 During the period 1951-56, there was an increasing trend in both the quantity and value of export of marine products. However, subsequent to 1956 there were some marked changes as evident from the analysis of triennial averages of quantities and values vide Appendix 40.6. Considering the first two triennials, it is seen that the average quantity during the triennium ending 1962 was reduced by about 50 per cent, whereas the reduction in terms of value was of the order of only 30 per cent, indicating a change in the export trend from low unit value items comprising mainly sun-dried and salt-cured products to high unit value items consisting mostly frozen prawns, lobster tails, froglegs etc. Since then there has been a rising trend both in terms of quantity and foreign exchange earnings. Another significant feature of the trend was that in the year of devaluation (1966) although the total quantity exported showed a slight increase of about 6 per cent over that of the triennium ending 1965, the increase in value terms was as much as 100 per cent.

40.2.4 Appendix 40.7 gives the percentage composition of different items, in terms of quantity and value, in the total export of marine products from India during the three years 1972-74. The main importing countries are also indicated against each item with percentage share in total annual average exports during these three years.

40.2.5 Frozen products : It is seen from Appendix 40.7 that frozen prawns, froglegs and lobster tails contribute as much as 80 per cent in terms of quantity and 90 per cent in terms of value to the export of marine products. It has been reported that 48 freezing plants have so far been installed with a processing capacity of about 60,000 tonnes per annum of which 83 per cent capacity (34 plants) is in Kerala State. The present capacity utilisation is only 30 per cent. It would, therefore, appear that this sector of the industry is overcapitalised. The so-called over-capitalisation has arisen on account of the need to process large quantities of prawns during the short season of availability. Despite this, it would be advisable to increase the utilisation of installed capacity as much as possible both for diversified production for export purposes and for domestic consumption, particularly because sardines, mackerel etc. are caught in sizeable quantities in the areas where frozon capacity has been largely established. We, therefore, recommend that the MPEDA should examine the question of increased utilisation of the installed capacity of freezing plants and storages for increasing export of marine products, and domestic consumption of frozen products.

40.2.6 The present status and the future potential of the export of prawns and lobsters have been dealt with in Chapter 39 on Crustacean Fisheries and their utilisation.

40.2.7 Froglegs: The export of this item has shown a fluctuating trend. The major importing countries are USA (72.88 per cent), Belgium (12.46 per cent) and France (10.00 per cent). The three species, *Rana tigrina*, *R. hexadactyla* and *R. crassa*, which have assumed commercial importance in the export of froglegs, are caught from natural resources. There are possibilities of increasing the export of froglegs by extending the popularity of this product in other countries for which the MPEDA will have to take necessary promotional steps. The need would then arise to increase production which may come from both, capture and culture operations. As regards capture operations it will have to be seen that the increased catches do not bring about depletion in the natural population of each of these three species. This would necessitate undertaking population surveys for which detailed methodology and guidelines have to be formulated. ICAR should prepare detailed methodology and set guidelines for undertaking population survey of commercial species of frogs by the State fisheries organisations. As regards culture of frogs, experimental studies have been conducted by the Central Inland Fisheries Research Institute (CIFRI) for several years and it has been reported that some encouraging results have been obtained. However, economic feasibility by undertaking a pilot project has not yet been established for adoption of field practices. It may be stated that there are extensive areas of freshwater swamps, some of which could be utilised if necessary economic feasibility is established as early as possible. It is, therefore, suggested that ICAR should undertake a pilot project for establishing economic feasibility of frog culture with view to adopting field practices in utilising some of the areas of freshwater swamps for undertaking frog culture.

40.2.8 Canned products: Canned prawns constitute the main product in this category contributing approximately 3.5 per cent of the total export trade of marine products from India. The export of other products such as canned tuna and other types of fishes and crab meat, which has been started in the recent years, is insignificant. It has been reported that fish canning capacity of nearly 11,000 tonnes per annum has been created but the utilisation is only 30 per cent. India has considerable scope for introducing diversified canned products for export, such as sardines, mackerel, seerfish also popularly known as king mackerel comparable to light meat tuna and several other varieties of fish, crustaceans including lobsters, prawns and crabs, molluscs comprising oysters, clams, mussels etc. By intensifying promotional programmes in the export of canned products by the MPEDA, India would not only be able to utilise its existing canning capacity but should be able to expand the facility for canned products. The industry would, however, be confronted with the problem arising out of high cost of cans manufactured from imported tin, which would constitute a constraint in the competitiveness of the canned products in the international export trade. For the furtherance of the export of the canned products, the industry should be supported by the supply of empty cans at subsidised rates.

40.2.9 Cured and dried products: It might be seen from Appendix 40.7 that there has been a downward trend in the export of these products. So far these products were mainly exported to Sri Lanka (86%), and it is very likely that this decline may be due to that country having undertaken programmes for expansion of fish production thereby curtailing the imports of fish from other countries. As such, it will be necessary to diversify the export of these products to other countries.

40.2.10 Fish maws and sharkfins: Fish maws are dried air-bladders of fishes such as *dara, ghol,* catfishes and eels. They are mainly used in breweries for the clarification of liquors and are mostly exported to UK. The dried fins of sharks, containing gelatin as a principal constituent, are used for preparing soups considered as delicacies. They are mainly exported to Singapore and Hong Kong. The prospects for increasing the export of these products would be marginal as there is a little scope for increasing production of fishes yielding these products.

40.2.11 Miscellaneous products : These include live aquarium fishes, aquatic plants, fish and prawn pickles, sea shells, fish oil, turtle meat and several other products. The export of these products has shown an increasing trend from 0.85 per cent to 1.80 per cent and has considerable scope for further expansion in future.

Scope for Diversification

40.2.12 It has been shown in the previous paragraphs that the main dependence in the export of marine products from India has, so far, been confined to prawns and their export too was limited mainly to two countries viz. USA and Japan. In the interest of future expansion in the export of marine products we feel that promotional measures by the MPEDA have to be considerably intensified for the diversification of both countries as well as products. To have an idea of the scope for diversification of products, the quantities of various major categories of products in the international export trade during 1973 are given below:

Category	Quantities (thousand tonnes)
chilled fish	774
frozen fish and fish products	1425
dried, salted and smoked fish	434
crustaceans—fresh, frozen and salted and smoked .	212
molluscs—fresh, frozen, and salted and smoked . .	243
canned products	
(i) fish	642
(ii) crustaceans	22
(iii) molluscs	20

It might be mentioned that as already stated except in the case of crustaceans in frozen form, particularly prawns, India does not contribute significantly in the world exports of the other items.

40.2.13 In order to create a viable processing industry in India for the expansion of the export of diversified marine products it would be necessary to create an internal market for domestic consumption of the similar products. Most of the countries which have progressively built up industrial capacity for the processing of diversified products have attained maximisation in the utilisation capacity of processing plants on this basis. It is, therefore, suggested that the public sector fishery corporations and private enterprises should come forward to create a suitable distribution and marketing systems for diversified products in the country.

Quality Improvement

40.2.14 Marine products for exports undergo preshipment inspection of sample quantities as mentioned in the paragraph 40.1.21. Although the introduction of the inspection system has progressively improved the quality of export products, there has been considerable amount of rejections by importing countries. To give an example, it has been mentioned by the MPEDA in the Marine Products Export Review of 1974 that there was high rate of rejections of Indian froglegs by the Food and Drug Administration in the USA. In spite of high demand the USA importers were hesitant to place orders with India since the insurance companies both in India and the USA were reluctant to give adequate insurance cover for this item due to fear of rejection. It seems, therefore, that there is a need to improve the quality of export products to avoid the incidence of rejections. In this context it may be stated that under the auspices of UNO, the FAO and WHO have jointly set up Codex Alimentarious in 1962 to collect the internationally adopted food standards for presenting them in a unified manner with a view to protecting the health of consumers all over the world and for introduction of fair practices in the international trade. Under this, there is a Codex Committee on Fish and Fishery product hosted by Norway. The eventual introduction of international standards would make it obligatory for Indian fish processing industry to be in preparedness for better quality of export products comparable to international standards. It is, therefore, suggested that the MPEDA should set up guidelines and procedures for necessary improvements in the processing sector of the fishing industry oriented for export purposes. Further the State Governments should give priority consideration to the adequate supply of potable quality of water and uninterrupted electric supply to the fish processing industry and the Central Government should ensure that the export consignments are given expeditious clearance.

3 INDUSTRIAL FISHERY

40.3.1 Fish meal: It is estimated that about one lakh tonnes of raw fish are being used for reduction to yield about 20,000 tonnes of fish meal. Of this, considerable quantity is of low quality produced at various centres in small quantities from sun-dried fish by pulverisation. Because of poor quality, major portion of this fish meal is marketed as manure. Better quality of fish meal is, at present, produced at 8 fish meal plants one each at Jaffarabad, Bombay, Malpe, Mangalore, Goa, Calicut, Azhikode and Mandapam. The total capacity of these plants is estimated to be about 200 tonnes in terms of raw material per day to yield about 40 tonnes of fish meal. Even this little installed capacity is being utilised to the extent of about 30-35 per cent only. For most of the shore-based fish meal plants in other countries, comparatively much greater utilisation capacity is made possible because of the availability of raw material in the form of offal from canning, filleting and other processing sectors of the industry, besides whole fish not suitable for human consumption. In India, whatever little capacity of shore-based fish meal plants has been created, the dependence has been only on whole fish as raw material. It is mainly on this account that owners of fish meal plants have been experiencing difficulties in getting adequate supplies of raw materials. Fish meal being an important constituent of livestock and poultry feeds, the demand for this product would grow several fold considering the expansion of livestock production programmes in the next 25 years. This commodity is also in great demand in international export trade. It may be of interest to note that nearly 30 per cent of the world production of 70 million tonnes of catch is directed for reduction into fish meal.

40.3.2 The trend in the development of this sector of fishing industry in most of the countries is to introduce more and more fish meal plants on board the larger fishing vessels for substantial increase in production of fish meal and oil. In this context the installation of pocket size fish meal plants on larger trawlers in the country to utilise the trash fish which is being discarded as at present, has already been suggested. In order to produce appreciable quantities of fish meal to meet the growing demand for preparation of livestock feed, it will be necessary to introduce small scale factory ships with small modernised fish meal plants on board, which could undertake fishing in the extended pelagic fisheries resources.

40.3.3 Fish body oil : This oil is prepared in India from oil sardines mainly in the States of Kerala and Karnataka during the peak fishing season of October-December. The yield of oil during this period is about 13 per cent. It is estimated that nearly 8,000 tonnes of sardine oil is being extracted. At most of the centres the oil is extracted in relatively smaller quantities by the age old traditional methods. The oil obtained by this way is of poor quality of dark brown colour and intense unpleasant odour due to decomposition of proteins. This quality of oil is mainly useful for painting traditional wooden boats to act as a water repellant. Other uses of this low grade oil are in leather processing, tempering of metals and in preparation of insecticidal soaps. The better quality oil is produced in wet reduction process employed for fishmeal as an additional product. The two fishmeal factories at Malpe and Mangalore have been producing good quality oil which is rich in long chain unsaturated fatty acid glycerides which can be put to different industrial uses. The stearin separated oil possesses properties of good drying oil and is used as a substitute for linseed oil in paint industry. This type of oil is also used in preparing artificial rubber filling compound, a base for manufacturing printing inks, lubricating oil and sulfonated products. The deodorised oil is used in the manufacture of soaps, in canning of fish and in the preparation of detergents, cosmetics and oil cloth. There would be good scope for increasing the production of fish body oil along with the fishmeal as a by product.

40.3.4 Shark liver oil: The shark liver oil industry in India is fairly well developed for vitamin 'A' preparation. There are well-established factories at Trivandrum, Calicut, Bombay, Veraval and Cuttack. The annual production of shark liver oil is estimated to be about 2,25,000 litres. These factories have experienced difficulty in getting adequate supplies of livers of sharks to maintain the production. The possibility of extracting oil from livers of rays needs to be examined. Although these may yield low potency oil, supply of livers would be supplemented as these fish would be caught in large quantities in the increased trawling effort in distant waters, where such fishes constitute a good proportion. It may, however, be stated that this industry has received a great set back after the introduction of synthetic vitamin 'A'. As such the possibility of augmenting production by increasing the number of units would not be feasible.

40.3.5 Masmin : Fairly large quantities of tuna landing in Lakshadweep are converted into a special product known as Masmin which is a delicacy in countries like Sri Lanka, Singapore, Malaya etc. Fresh fish immediately after landing is beheaded and gutted and suitable fillets are made. The normal size is 12 to 17 cm in length and 4 to 5 cm in thickness. Fillets are thoroughly washed and wrapped individually with ribbon-like split coconut leaves to prevent the fillets from breaking up into small pieces during cooking. These wrapped fillets are then cooked in 3 per cent brine (sea water is also used instead of brine) for about one hour. After cooling sufficiently, the wrapped pieces are smoked for 3 to 4 hours. The coconut leaves are then removed and the fillets dried in the sun. Smoking and drying processes are repeated until products become finally hard and dark brown like dry pieces of wood. The finished product is stored in gunny bags or boxes. The masmin produced commercially is of low quality and has a poor shelf-life. There is scope for improvement of the texture and need to enhance the storage-life by incorporation of preservatives to ward off bacterial spoilage and insect infestation. Proper packing methods also need to be developed.

40.3.6 Crab concentrate : This product is a delicacy and is a very popular item of prepared fish foods in many countries. European and USA markets hold excellent prospects for the product. For the preparation of the product, the crabs are cleaned thoroughly free of dirt and dipped in boiling water for 20 minutes. They are taken out and cooled well under a fan. The crabs are split open at the belly portion and meat removed which is then blended with an equal amount of water adding sufficient salt to taste. The whole mass is concentrated in a steam heated open stainless steel vessel until its moisture content is about 65 per cent. The concentrate (150-160 gm) is filled into clean lacquered cans (301×206) leaving a head space of 4—8 mm. The cans are exhausted, sealed in a double seamer and processed for 30 minutes.

40.3.7 Turtle meat: The green turtle *Chdlonia mydas* Linn.) is the commercial edible species used in processing. These turtles are caught near the coral reefs which abound along the coast from Rameshwaram down to Cape Comorin. Annually 800 to 1,000 turtles are caught in this area most of which are sent to Sri Lanka. A lucrative market has been found recently in West Germany for frozen dressed turtle meat. After removal of viscera, the back shell carcass is cut into pieces and packed in boxes lined with polythene film and frozen in blast freezer. The belly shell with the meat is cut into pieces and likewise frozen in boxes. Alternatively, the pieces are packed in individual polythene bags, frozen in blast freezer prepared in master cartons or boxes for export. The red meat in the flippers is separately cut out, removed of all bones, frozen and packed in cartons or boxes. The flippers without red meat and bones are also likewise frozen. The yield of the edible material is about 30 to 40 per cent. Dried turtle meat used as soup stock in Western countries is also exported in small quantities.

40.3.8 Fish paste and fish sausages: Fish paste is a general term used for fish food manufactured from ground fish meat and seasoning materials like sugar, salt and mono-sodium glutamate. These products which come under the category of 'ready to serve' dishes are popular in many countries like USA, Canada and Japan. Attempts at manufacturing fish paste and fish sausages have not yet been initiated in the country for want of suitable and effective preservatives. The products that may be produced on a commercial scale include tuna paste, prawn paste and squid paste.

40.3.9 For the preparation of sausages, the blended paste prepared from raw material is incorporated with flavouring agents (powdered spices-pepper, clove, garlic, onion powder or liquid mustard), preservative and a permitted food colour and packed into casings. The edible casings are usually animal intestines and synthetic casing is polyvinylidine chloride.

40.3.10 Fish hydrolysates: Fish protein can be hydrolysed to proteoses, peptones, peptides and amino acids employing protoelytic enzymes like papain and pancreatin or by acid hydrolysis. The hydrolysates containing peptones and aminoacids are excellent products having high nutritional value. Easily digestible protein rich energy foods for infants and the convalescents can be produced by incorporating fish hydrolysate. Cocoa flavoured, vitamin enriched energy food thus prepared from the hydrolysates has been shown to have good acceptability.

40.3.11 Shark skin leather: From the total quantity of various types of sharks landed in this country, it is roughly estimated that about 2 million square feet of shark skin can be available for the manufacture of leather. The skin which is very tough can yield good quality leather which compares very well with any other good quality leather. This leather can be used for the manufacture of shoes, hand bags, straps and many other fancy items. The skin is attached very firmly to the flesh and it requires a special skill to peel it off in the fresh shark. This is a very important preliminary step in getting a good quality leather after tanning. CIFT has worked out a method for the successful removal of the skin from shark. Recent trials conducted at the leather Research Institute in collaboration with the CIFT have produced good quality leather from which a number of fancy articles were made and exhibited.

40.3.12 Fish glue: Excellent fish glue can be manufactured from the skin and bones of fish containing large amounts of collagen. Fish glue usually contains significant quantities of proteins and peptone and is therefore inclined to be soluble in cold water. Dialysis to remove salts and subsequent evaporation is the simplest and cheapest method for manufacturing fish glue. As an adhesive, this has extensive application.

40.3.13 Pearl essence: Scales of several species of fish yield small lustrous crystals of purine and guanine and these form the basis of the pearl essence, which is used to coat the surface of artificial pearls.

40.3.14 General considerations: Although considerable spadework has been done by CIFT on the possibilities of preparing various industrial fishery products, there is yet no established industry worth the name for utilising the new material wherever available. It is, therefore, suggested that CIFT should prepare techno-economic feasibility reports for manufacturing various minor fishery industrial products on small scale industry basis.

4 SUMMARY OF RECOMMENDATIONS

40.4.1 A summary of the main recommendations is as under:

1. Marketing base for marine fish caught in large quantities and comparatively cheap in price, should be extended to the inland areas, particularly in the eastern States where there is considerable demand for fish.

(Paragraph 40.1.5)

2. With a large variety of fishes composing marine catch and the demand getting concentrated only to a few popular and prime fishes, there is an imperative need of improving the marketability of lesser known fishes. The fish consuming public should be made conscious about the necessity of chilling fish for maintaining the freshness and nutritive value. The preparation of wholesome fish fillets on industrial scale should be encouraged. Fish offal obtained as by product could be used for fishmeal manufacture. These objectives may be achieved through various media of mass communication.

(Paragraphs 40.1.6 and 40.1.22)

3. To help data collection for market intelligence an evaluation of production economics, the States should examine the introduction of a system of standards for different types and sizes of marine fish at the primary marketing stage.

(Paragraph 40.1.8)

4. Hygienic marketing sheds should be provided at suitable fish landing centres.

(Paragraphs 40.1.9 and 40.1.11)

5. The firsh landing sites with adequate marketable surplus should be linked with the nearest railway stations or motorable roads by providing feeder roads for quick transport and distribution of fish.

(Paragraph 40.1.10)

6. The State fisheries organisations and marketing authorities should jointly examine the question of eliminating unnecessary links in the prevailing trade practices and introduce the system of licensed functionaries to the best advantage of the producers and the consumers.

(Paragraph 40.1.17)

7. Fisheries co-operatives should assume an increasing role in developing marketing functions by raising the standards of efficiency in marketing methods and by making marketing as an obligatory function in the bye-laws of the co-operatives. The co-operatives should be provided with necessary credit for working capital from governmental resources and from the financial institutions.

(Paragraph 40.1.18)

8. For improving quality control and inspection of fish and fishery products, short-term training courses should be organised at suitable Central fisheries institutes for public health services personnel. Necessary national standards for analytical methods for quality control and inspection should be formulated jointly by the ISI and Central and States fisheries organisations.

(Paragraph 40.1.21)

9. The CIFT should intensify research on proper procedures for chilling different types of fishes and then formulate necessary specifications on the methods of packing fish and ice in suitable containers with economical insulation materials as early as possible so that these could be adopted by the trade.

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(Paragraph 40.1.23)

10. The CIFT should undertake pilot projects in co-ordination with State fisheries organisations to demonstrate the economic advantages of mechanical air-dryers over the existing traditional methods in some of the suitable areas where sun-drying of fish is being predominantly undertaken.

(Paragraph 40.1.24)

11. The Central Fisheries Corporation in coordination with State fisheries corporations/organisations should establish freezing plants and storages near the production centres wherefrom bulk quantities of marine fish could be absorbed at comparatively cheaper price. This would relieve gluts, thereby giving an economic advantage to the producers and also increase supplies of fish in seasons of shortage at reasonable price to the consumers even at distant centres, particularly in the sectors of the country where fish constitutes an important item of food.

(Paragraphs 40.1.26 and 40.1.27)

12. For improving the transport system for carriage of iced and frozen fish to be sold as thawed fish (iced fish) the question of introducing insulated rail and road vans on a large scale to meet the expanding marketing activity should be examined as a step towards the development of refrigerated transport systems.

(Paragraph 40.1.30)

13. India's share in the international export trade of marine products being negligible, the MPEDA should intensify promotional measures to expand the export trade.

(Paragraph 40.2.1)

14. The anomaly regarding the assumption of the functions by the MPEDA with reference to development, conservation and management of off-shore and deep sea fisheries as laid down in the Act 13 of 1972 should be removed by the Government in the interest of this Authority directing its well-concerted efforts towards the promotion of export of marine products.

(Paragraph 40.2.2)

15. The installed freezing capacity remaining considerably unutilised, the MPEDA should examine the question of its increased utilisation for increasing exports of marine products and for freezing products for domestic consumption.

(Paragraph 40.2.5)

16. The MPEDA should increase the export of froglegs by popularising this product in affluent countries. The need for increasing production of froglegs both by capture and culture operations would then arise. For increasing production by capture operations the CIFRI should prepare detailed methodology and set guidelines for undertaking population surveys for commercial species of frogs by the State fisheries organisations. As regards culture operations, the ICAR should undertake a pilot project for establishing economic feasibility of frog culture with a view to adopting field practices in utilising freshwater swamps for frog culture.

(Paragraph 40.2.7)

17. With considerable prospects of increasing exports of diversified canned products by necessary promotional measures by MPEDA, it should not only be possible fully to utilise the installed fish canning capacity, but there should be scope to increase the same in future. However to enable the Indian fish canning industry to compete in the international export trade, empty cans, manufactured from imported tin plate, should be supplied at subsidised rates.

(Paragraph 40.2.8)

18. With main dependence for cured products only on Sri Lanka, the MPEDA should diversify the export of dried and cured products.

(Paragraph 40.2.9)

19. To improve the quality of export products, the MPEDA should set necessary guidelines and procedures for the processing sector of the fishing industry oriented for export purposes. Further the State Governments should give priority considerations to the adequate supplies of potable water and uninterrupted electricity supply to the fish processing industry and the Central Government should see that the export consignments are given expeditious clearance.

(Paragraph 40.2.14)

20. To increase production of fishmeal and incidentally fish oil in the same plants, introduction of a few small scale factory ships with fishmeal plants on board should be encouraged.

(Paragraph 40.3.2)

21. The CIFT should prepare techno-economic feasibility reports for manufacturing various minor fishery industrial products on small scale industry basis.

(Paragraph 40.3.14)

APPENDIX 40·1

(Paragraphs 40.1.2, 40.1.11 and 40.1.12)

Per Capita Availability of Fish in Different States

State/Union Territory	Population, 1971 (in 1000)	Fish production in 1973 (1000 tonnes)			Annual per capita availability of fish (in kg.)			
		marine	inland	total	marine	inland	total	adjusted to fish and meat eating Population
1	2	3	4	5	6	7	8	9
Andhra Pradesh	43,503	116·73	89·61	206·34	2·68	2·06	4·74	5·93
Assam	14,958*	..	30·00*	30·00*	..	2·01	2·01	2·11
Bihar	56,353	..	67·12	67·12	..	1·19	1·19	1·49
Gujarat	26,697	151·20	14·56	165·76	5·66	0·55	6·21	17·74
Haryana	10,037	..	1·00	1·00	..	0·10	0·10	0·20
Himachal Pradesh	3,460	..	0·73	0·73	..	0·21	0·21	..
Jammu & Kashmir	4,617	..	7·59	7·59	..	1·64	1·64	2·05
Karnataka	29,299	55·11	60·00	115·11	1·89	2·04	3·93	4·91
Kerala	21,347	350·76@	17·84@	368·60@	16·44	0·83	17·27	21·58
Madhya Pradesh	41,654	..	9·00	9·00	..	0·22	0·22	0·44
Maharashtra	50,412	292·32	15·50	307·82	5·80	0·31	6·11	8·72
Manipur	1,073	..	1·20	1·20	..	1·12	1·12	..
Meghalaya	1,012	..	0·80	0·80	..	0·79	0·79	..
Nagaland	516	..	0·12	0·12	..	0·23	0·23	..

APPENDIX 40.1 (contd.)

1	2	3	4	5	6	7	8	9
Orissa	21,945	17·00	23·00	40·00	0·77	1·05	1·82	2·27
Punjab	13,551	..	1·71	1·71	..	0·13	0·13	0·26
Rajasthan	25,766	..	7·98@	7·98	..	0·31	0·31	0·77
Tamil Nadu	41,199	182·53@	135·00	317·53@	4·43	3·28	7·71	9·63
Tripura	1,556	..	4·15	4·15	..	2·67	2·67	..
Uttar Pradesh	88,341	..	23·40	23·40	..	0·26	0·26	0·47
West Bengal	44,312	8·85	235·15	244·00	0·20	5·31	5·51	5·82
Andaman & Nicobar Islands	115	0·85	..	0·85	7·39	..	7·39	..
Arunachal Pradesh	468	..	0·18	0·18	..	0·38	0·38	..
Chandigarh	257	..	..	..	..	..	..	..
Dadra & Nagar Haveli	74	..	..	..	—	..	..	..
Delhi	4,066	..	0·22	0·22	..	0·05	0·05	..
Goa, Daman & Diu	858	15·74@	1·21@	16·95@	18·34	1·42	19·76	..
Lakshadweep	32	1·85	..	1·85	57·81	..	57·81	..
Mizoram	+	..	+	+	—	+	+	..
Pondicherry	472	17·51	0·48	17·99	37·10	1·01	38·11	..
All India	547,950	1210·45	747·55	1958·00	2·21	1·36	3·57	..

*Includes Mizoram.

+Included under Assam.

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APPENDIX 40·2

(Paragraph 40.1.7)

Average Quarterwise Marine Fish Landings on East and West Coasts (1963—72)

(in tonnes)

Period	East coast				West coast					
	West Bengal Orissa	Andhra Pradesh	Tamil Nadu	Total (2 to 4)	Kerala	Karnataka	Maha-rashtra	Gujarat	Total (6 to 9)	Total (5 +10)
First quarter (Jan-March)	4894·4 (27·27)	26172·8 (34·15)	35287·9 (25·51)	66355·1 (28·48)	79385·6 (23·76)	21253·8 (26·75)	34298·9 (21·79)	20965·3 (24·74)	155903·6 (23·77)	222258·7 (25·01)
second quarter . .	1947·8 (10·85)	15787·2 (20·59)	33581·6 (24·27)	51316·6 (22·03)	40629·7 (12·16)	5342·3 (6·72)	38947·0 (24·74)	10829·3 (12·78)	95748·3 (14·60)	147064·9 (16·58)
third quarter. . .	2592·7 (14·44)	16388·1 (21·38)	35094·7 (28·26)	58075·5 (24·93)	80320·0 (24·04)	4922·3 (6·20)	10800·2 (6·90)	4122·2 (4·86)	100224·7 (15·28)	158300·2 (17·81)
fourth quarter . .	8515·6 (47·44)	18307·1 (23·88)	30389·5 (21·96)	57212·2 (24·56)	133818·2 (40·04)	47923·3 (60·33)	73311·7 (46·57)	48818·0 (57·62)	303871·2 (46·35)	361083·4 (40·63)
annual. . . .	17950·5 (100·00)	76655·2 (100·00)	138353·7 (100·00)	232959·4 (100·00)	334153·5 (100·00)	79441·7 (100·00)	157417·8 (100·00)	84734·8 (100·00)	655747·8 (100·00)	888707·2 (100·00)

Figures in brackets indicate the percentage of the total (annual).

APPENDIX 40·3

(Paragraph 40.1.16)

Supply and Demand Projections

Year	Population (million)	Non-veg. population (70% of col. 2) (million)	Supply (million tonnes)			Export (million tonnes)	Used in fishmeal and other industrial products (million tonnes)	Balance as fish food for domestic consumption (million tonnes)	Per capita availability kg/annum	Demand as per nutritional standard @11 kg per capita per annum (million tonnes)
			Inland	Marine	Total					
1971	547·0	382·90	0·70	1·10	1·80	0·04	0·15	1·61	4·2	4·21
1985	724·5	507·43	2·22	2·06	4·28	0·10	0·40	3·78	7·4	5·58
2000	935·4	654·78	4·50	3·50	8·00	0·25	1·00	6·75	10·3	7·20

APPENDIX 40·4

(Paragraph 40.1.49)

Utilisation Pattern of Inland and Marine Fish

(thousand tonnes)

Year	Inland fish	Marine fish									Grand total (inland and marine)
	Fresh	Fresh	Freezing	Curing		Canning	Fish meal	Miscellaneous	Total marine		
				Sundried	Salting						
1951		217·2	103·5 (19·4)*	..	194·6 (36·4)	186·2 (34·9)	.. ..	49·6 (9·3)	..	533·9 (100·0)	751·1
1956		293·5	138·8 (19·3)	..	262·2 (36·5)	251·8 (34·9)	..	66·8 (9·3)	..	718·8 (100·0)	1012·3
1961		277·4	183·0 (26·8)	..	222·9 (32·6)	197·0 (28·8)	..	80·7 (11·8)	..	683·6 (100·0)	961·0
1966		477·1	486·0 (54.6)	26·2 (2·9)	158·2 (17·8)	141·5 (15·9)	7·8 (0·9)	59·5 (6·7)	11·1 (1·2)	890·3 (100·00)	1367·4
1971		690·2	534·4 (46·0)	97·6 (8·4)	249·6 (21·5)	107·8 (9·3)	13·1 (1·1)	105·6 (9·1)	53·2 (4·6)	1161·4 (100·0)	1851·6

*Figures in parenthesis denote the percentage utilisation of marine fish.

APPENDIX 40.5

(Paragraph 40.1.21)

List of Fish and Fishery Products under Indian Standard Specifications

Name of specification	Specification number and year of publication
1	2
A. fresh fish	
fresh silver pomphret and brown pomphret	4780—1968
fresh threadfin	4781—1968
Mackerel, fresh	6032—1971
B. frozen fish and shell fish	
frozen prawns (shrimp)(First revision)	2237—1971
frozen froglegs	2885—1964
frozen lobster tails	3892—1966
frozen silver pomphrets and brown pomphrets	4793—1968
frozen threadfin	4796—1968
Mackerel, frozen	6033—1971
Seer fish (*Scomberomorus* spp.) (frozen)	6122—1971
C. canned fish and shell fish	
Pomphret canned in oil	2168—1962
Prawns (shrimp) canned in brine (First revision)	2236—1968
Mackerel (*Rastrelliger* spp.) canned in oil	2420—1963
Sardines (*Sardinella* spp.) canned in oil	2421—1963
Lactarius spp. canned in oil	6121—1971
Mackerel (*Restreliger* spp.) canned in brine	3849—1966
Tuna canned in oil	4304—1967
D. dried fish and shell fish	
dried prawn pulp	2345—1963
dried white baits (*Anchoviella* spp.)	2883—1964
dried and laminated Bombay duck	2884—1964
dry salted mackerel	4302—1967
dry salted seer fish	5198—1969
dry salted shark	5199—1969
dry salted suran (tuna)	5736—1970
dry salted threadfin (Dara) and dry salted jew fish (Ghol)	3850—1966

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APPENDIX 40.5 (*Contd.*)

1	2
dry salted cat fish	3851—1966
dry salted leather jacket (*Chorinemus* spp.)	3852—1963
dry salted horse mackerel (*Caranx* spp.)	3853—1969
dried shark fin	5471—1969
fish mews	5472—1969
E. miscellaneous	
code for sanitary conditions, handling transport in fish industry, preprocessing stage—part I pre-processing stage.	4303—part I 1967
code for sanitary conditions, handling transport in fish industry, preprocessing stage—part II sanitary conditions.	4303—part II 1967
for fish processing units.	
recommendations for maintenance of cleanliness in fish industry.	5735—1970
fish meal as livestock feed	4307—1967
shark liver oil for veterinary use	3336—1965
sardine oil	5734—1970

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APPENDIX 40·6

(Paragraph 40·2·3)

Trends in the Export of Marine Products during 1957—73

Period	Triennial averages	
	Quantity (thousand tonnes)	Value (Rs. in crores)
pre-devaluation		
1957—59	29.1	5.6
1960—62	15.1	4.0
1963—65	18.3	6.5
devaluation*		
1966 (single year)	19.2	13.5
post devaluation		
1967—69	25.7	25.0
1970—72	36.5	44.3
1973 (single year)	48.8	79.6

*Devaluation of Indian Currency took place in June, 1966.

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APPENDIX 40·7

(Paragraph 40.2.4)

Percentage Composition of Different Marine Products in the Export Trade during 1972-74 and Major Importing Countries, with Relative Percentages

Item	Quantities			Values			Major importing countries
	1972	1973	1974	1972	1973	1974	
1	2	3	4	5	6	7	8
frozen Prawn . .	79.83	73·59	73·69	87·53	82·70	83·52	Japan 53.62 USA 38·98 Australia 2.80 Others 4·60
frog legs . . .	4·76	5·53	3·12	3·73	5·65	3·75	USA 72·88 Belgium 12·46 France 10·00 Others 4·66
lobster tails . .	0·96	0·78	0·98	2·20	1·34	1·65	USA 95·28 Others 4·72
	85·55	79·89	77·79	93·46	89·69	88·92	
canned Prawns . .	2·76	4·51	3·25	3·61	6·58	6·27	UK 46·38 France 21·16 USA 4·86 Canada 2·30 Others 15·40
cured or dried prawns	0.36	0.58	0.25	0.24	0.41	0.19	Hong Kong 27·64 Netherlands 13·91 UK 12·80 France 11·50 USA 8·90 Japan 6·12 Others 19·13

1	2	3	4	5	6	7	8
fish	9·09	6·94	3·75	1·37	1·38	0·87	SriLanka Mauritius Others 86·54 10·04 3·42
shark fins & fish maws .	0·77	0·52	0·58	1·04	0·83	1·11	Singapore Hong Kong UK Others 60.44 22.76 16.42 0·38
fish meal . . .	0·62	6·26	12·58	0·03	0·38	0·77	Iran Sri Lanka Japan Italy 61·24 16·66 12·68 5·47 West Germany Others 2·06 14·39
miscellaneous products.	0·85	1·30	1·80	0·25	0·73	1·87	different countries
	100·00	100·00	100·00	100·00	100·00	100·00	

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